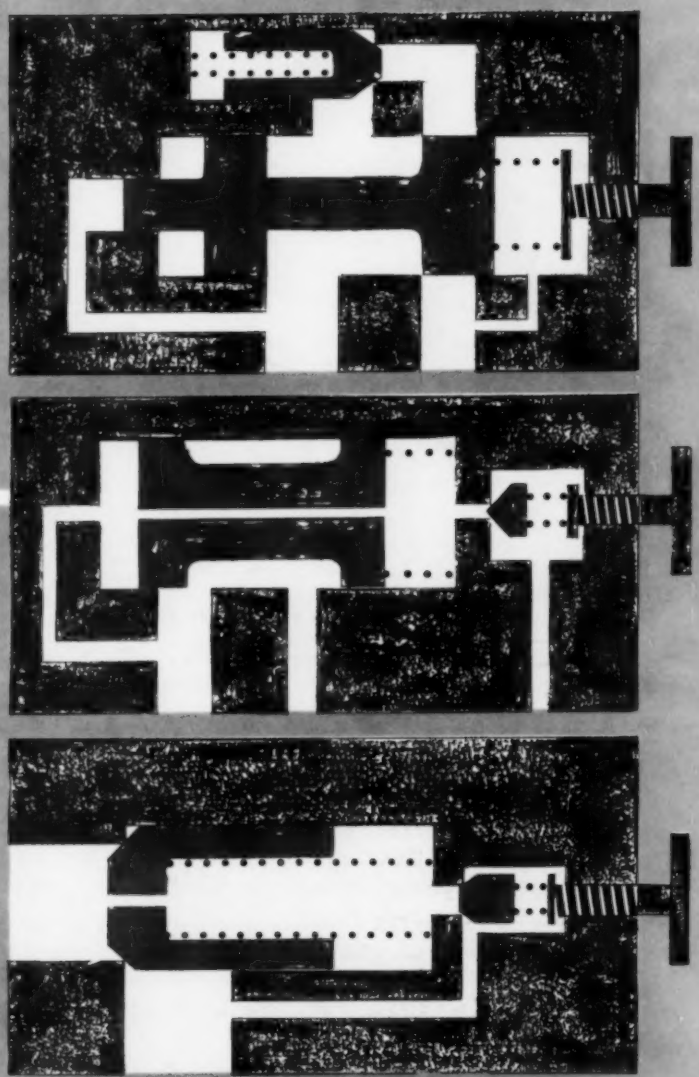
Hydraulics & Pneumatics

APRIL 1961

A COURSE IN HYDRAULIC VALVES PART 2

Pressure Control Valves



UNIVERSITY MICROFILMS
313 NORTH FIRST ST INC
ANN ARBOR MICH
AI-P221A

ALSO IN THIS ISSUE:

Electrohydraulic Analogies – Part 2
Reducing Hydraulic Noise
Circuits for Handling Shipboard Missiles

THE MAGAZINE OF FLUID POWER

AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

Plan to attend

ASME Design Engineering Show • Detroit, May 22-25

ASTME Tool Exposition • New York, May 22-26

See the May issue for complete coverage.

As easy as plugging in your electric shaver...

QUICK
FLUID LINE
CONNECTION
or
DISCONNECTION

with
INSTANT
AUTOMATIC FLOW
or
SHUT-OFF

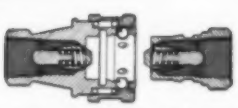
HANSEN

SERIES HK® QUICK-CONNECTIVE
TWO-WAY SHUT-OFF COUPLINGS

Hydraulic and pneumatic lines are quickly and easily connected with Hansen Series HK Two-Way Shut-Off Couplings. No tools required.

When Coupling is disconnected, valves contact valve seats in both Socket and Plug to provide instant and positive seal of fluid in both ends of line. Coupling does not depend upon line pressure to seal either end of line.

Hansen Series HK Couplings are furnished in steel or brass, with female pipe thread connections from ⅛" to 1½" respectively. Sizes up to 1" are also now available in stainless steel.



Instantly shuts off both sides of line... prevents loss of liquid, gas or pressure.

Quick-Connective Fluid Line Couplings for

COMPRESSED AIR • HYDRAULIC FLUIDS
WATER • VACUUM • STEAM • OXYGEN
ACETYLENE • REFRIGERANTS • GASOLINE
OIL • GREASE • COOLANTS • LP-GAS

Write for the Hansen Catalog

Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings.

Representatives in Principal Cities... See Yellow Pages

SINCE 1915 — QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

Circle **51** on Reader Service Card

...unusual features solve your cylinder problems

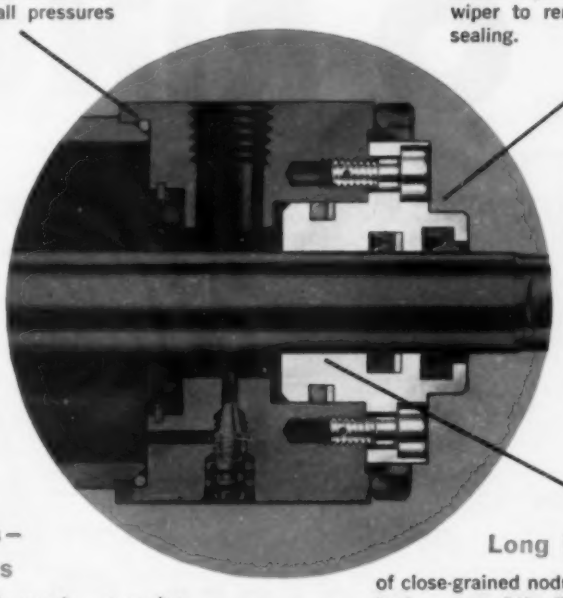
NEW HANNA *Powrmation* SERIES 1000 CYLINDERS

Pressure Safe Tube Seals

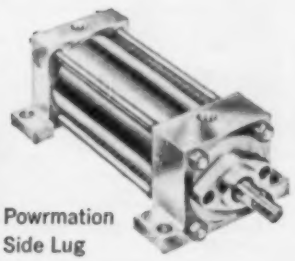
on the outside diameter of the tube create the most positive seal possible at all pressures from zero to maximum.

Fast Change Cartridge Gland

has leak-proof, low-friction rod seal and a rod wiper to remove dirt and to provide extra sealing.



Powrmation
Rectangular Flange
Rod End



Powrmation
Side Lug
Mounting

**One Piece Steel Heads–
Welded Steel Mountings**

for maximum strength, perfect alignment . . . superior to bolted assembly. Mountings carry maximum cylinder load with ample safety margin.

Long Lubricated Bearing

of close-grained nodular iron with high graphitic content . . . one of the finest bearing materials. Rod seal on external side of bearing provides automatic bearing lubrication by hydraulic fluid or airborne lubricant.

POWRMATION CYLINDERS FOR AIR TO 250 PSI • HYDRAULIC TO 1000 PSI • BORES: 1½" THROUGH 14"

All good cylinders have "features" but few have a combination of really *Unusual* features that assure superior cylinder performance and dependability . . . New Hanna Powrmation Cylinders have. The features shown above and several others like: Unique, Check-Valve Cushions; Low Friction Nodular Iron Pistons; Positive Seal Block Vee Packings; Chrome Plated High Strength Steel Rod;—all these together with Hanna precision manufacturing and Hanna Field Engineering Service are the reasons why it will pay you to specify Powrmation Cylinders . . . they meet J.I.C. recommendations and have dimensional interchangeability.

For Top Performance in Hydraulic Pressures

2000 PSI/3000 PSI Non Shock
HANNA POWRDRAULIC
Series 2000 CYLINDERS
Bores 1½" thru 8"

Write for Catalog 1000

or ask Your Hanna Representative—see the Yellow Pages or Sweet's Design Catalog for his name

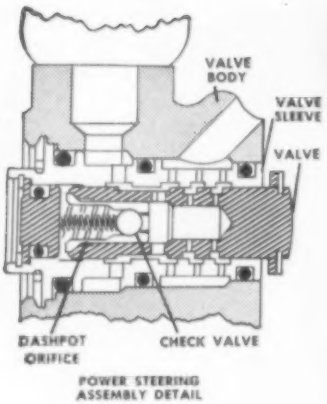
HANNA ENGINEERING WORKS

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES

1741 Elston Avenue • Chicago 22, Illinois

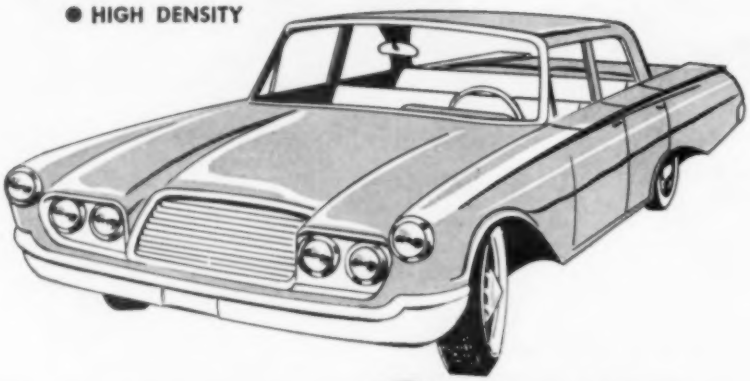
MINNESOTA MR RUBBER

FACTS for FILING on O-RINGS



POWER STEERING ASSEMBLY DETAIL

- EXCLUSIVE INJECTION MOLDED
- HIGH DENSITY



- WEAR RESISTANT
- CUSTOM COMPOUNDS

INJECTION MOLDED O-RINGS give better service in any application

EXCLUSIVE INJECTION MOLDING—This advanced molding technique produces an O-ring with amazingly close tolerances. It also reduces to a minimum variations in part thickness and virtually eliminates flash. Specifying injection molded O-rings for your equipment insures you of top sealing efficiency.

HIGH DENSITY—The higher, more uniform density found in injection molded O-rings increases resistance to abrasion and chemicals. This outstanding toughness and durability means better sealing and longer seal life.

WEAR RESISTANT — Reciprocating, rotary, static or oscillating, no matter what the application, injection molded O-rings resist wear and damage due to extrusion for thousands of cycles longer than ordinary O-rings. They reduce replacement and loss of production due to downtime, making big savings possible.

CUSTOM COMPOUNDS—MR's industrial, standard compounds will give outstanding service under most operating conditions. For those unusual applications, however, you can rely on MR to come up with a special compound designed for you, whether out of a common elastomer or an exotic one like Silicone or Viton A.

ONLY MINNESOTA RUBBER CAN GIVE YOU COMPLETE DESIGN, ENGINEERING AND PRODUCTION SERVICES ON YOUR RUBBER REQUIREMENTS.

FOR MORE INFORMATION ON INJECTION MOLDED O-RINGS

WRITE:

MINNESOTA MR RUBBER

NFPA

DEPARTMENT 122 • 3630 WOODDALE AVENUE
MINNEAPOLIS 16, MINNESOTA

WRITE ON YOUR LETTERHEAD FOR A FREE "MR FACTS FOR FILING" COVER.

OFFICES IN:
New York • Philadelphia • Cleveland • Buffalo • Detroit • Chicago • Milwaukee • St. Louis • Denver • Houston • Los Angeles • Portland • Quad Cities • St. Joseph, Mich. • Dallas

Hydraulics & Pneumatics

VOLUME 14/NUMBER 4

APRIL 1961

THE MAGAZINE OF FLUID POWER

ALLAN E. MORRIS
editor

JACK LOWERY
associate editor

TOBI GOLDOFTAS
associate editor

EDWIN JACOBS
assistant editor

JAY MYERS
assistant editor

BERT BENKENDORF
art editor

HENRY LEFER
eastern editor, New York

SCHOLER BANGS
western editor, Los Angeles

JOHN A. LANKESTER, A.R.Ae.S.
European editor

ALARIC MAUSSER
art director

DEPARTMENTS

10 . . . Fluid Power Lines
14 . . . Letters to the Editor
20 . . . Fluid Power Forum
30 . . . Fluid Power at Work
53 . . . Future Events
58 . . . New Products
62 . . . New Literature
112 . . . Aerospace Component Data
120 . . . Aerospace News
126 . . . Fluid Power Patents
140 . . . Post Scripts of Industry
145 . . . Market Place
146 . . . Advertisers' Index
148 . . . Reader Service Index

BASIC FLUID POWER DESIGN

A Course in Hydraulic Valves 69
Part 2—Pressure Control Valves

Electrohydraulic Analogies . . . Systems Approach to Fluid Power Design 78
Part 2—Development of Dynamic Circuit Elements
By Robert E. Raymond

A 5-Point Program for Air Valve Maintenance 84
By Edmond C. Powers

Reducing Hydraulic Noise 90
By Edward M. Herrmann

FLUID POWER APPLICATIONS

Single Strand Tensioning Eliminates Pump Slip Effect 86
By James S. Simms

Pilot Circuit Sequences Air Motor and Cylinder Movement 92
By W. C. Thompson

Regenerative Test Circuits Save Power 94
By John D. Dietiker

Circuits for Handling Shipboard Missiles 97
By Kurt Pollack

AEROSPACE SECTION

Fast Temperature Compensation with a Bootstrap Sump 104
By Michael Voytish, Jr.

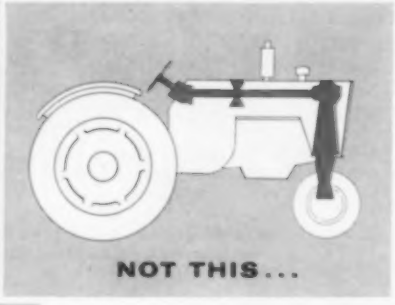
Learning to Live with Contamination 108
By Gerald A. Levine

copyright 1961 *by The Industrial Publishing Corporation*

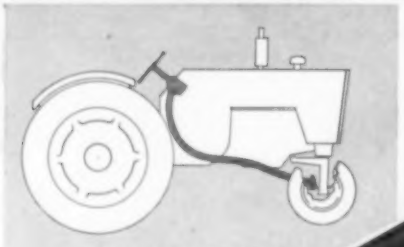
BPA

Char-Lynn "ORBITROL"®

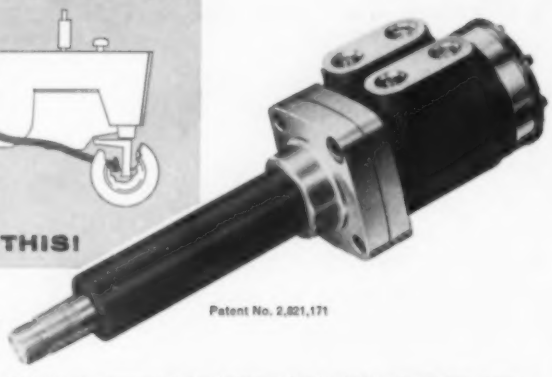
PROVIDES FULL FLUID STEERING *without* MECHANICAL LINKAGE



NOT THIS...



BUT THIS!



Patent No. 2,821,171

The New **ORBITROL is a completely integrated fluid steering control** system that eliminates steering gear boxes and mechanical linkages to the axle.

Only **ORBITROL provides remote rotary servo control** with sensory direction and delivery measurement within the same unit . . . the **ideal** concept for modern self-propelled vehicles.

ORBITROL also features integral manual steering for use in emergency or "engine-off" conditions . . .

When live hydraulic power is not available the ORBITROL automatically becomes a rotary hand pump and directs fluid to move the actuator in either direction when the steering wheel is rotated.

The ORBITROL is ideally suited for controlling conventional steering systems, multiple axles and dual control installations.

Contact CHAR-LYNN today . . . our engineers will be pleased to submit recommendations relative to your particular application or needs.

Char-Lynn

CHAR-LYNN CO.
Hydraulic Horsepower Products
Dept. HP-4
3843 26th Avenue South
Minneapolis, Minnesota
PArkway 1-5761

Circle **27** on Reader Service Card

Hydraulics & Pneumatics

THE MAGAZINE OF FLUID POWER

BUSINESS STAFF

ROBERT D. SHATTUCK — *business manager*
JAY MYERS — *production manager*
N. G. KISER — *circulation manager*
ROBERT GAUVIN — *reader service*

FRANCHISE DEPARTMENT

HAROLD ROBERTS — *representative*
RICHARD PLANCK — *production*

SALES OFFICES

Cleveland 15
812 Huron Rd., SU 1-9620
ROBERT G. JOSEPH

New York City 17
Rm. 835, 60 E. 42 St., MU 7-3420
LEE HAAS, *vice-president*
DAN J. ROWLAND

Chicago 11
Rm. 704, 520 N. Michigan
WH 3-1655
CHARLES F. GEYER, *vice-president*
SAM TRACY

Los Angeles 57
Granada Building
672 S. Lafayette Park Pl.,
DU 7-5104
ALAN T. CAZIER, *manager*
PAUL MANNING

London, S. W. 1
36 Victoria St.
SULlivan 6072
JOHN A. LANKESTER, *manager*

SUBSCRIPTIONS in U.S. and possessions: $7.00, 1 year; $12.00, 2 years. Canada: $7.00 per year. Foreign: $10.00 per year, payable in advance in U.S. funds. U.K.: £3.5.0 per year payable in Sterling to London office. Single copy price: 75 cents.

Out-of-print copies of HYDRAULICS & PNEUMATICS Magazine are available in complete volumes as positive microfilm copies from: University Microfilms, 313 N. First Street, Ann Arbor, Michigan.

published monthly by

The INDUSTRIAL PUBLISHING CORPORATION

812 Huron Rd., Cleveland 15, Ohio

LESTER P. AURBACH — *president*
EDWIN M. JOSEPH — *executive v.p.*
PAUL ROLNICK — *vice president*
N. N. GOODMAN, JR. — *vice president*
LEE HAAS — *vice president*
CHARLES F. GEYER — *vice president*
TOM DEMPSEY — *asst. sec. treas.*

AFFILIATED PUBLICATIONS:

Material Handling Engineering (formerly Flow), Handling & Shipping, Modern Office Procedures, Occupational Hazards, Power Transmission Design, Precision Metal Molding, The Refrigeration & Airconditioning Business, Welding Design & Fabrication. Member BPA.

Published monthly. Accepted as controlled circulation publication at Pontiac, Illinois. Please return 3579 forms to 812 Huron Road, Cleveland 15, Ohio. Printed in U.S.A

USEFUL LITERATURE

NEW CATALOG FOR REPLACEMENT LINE OF ANCHOR HYDRAULIC HOSE ASSEMBLIES, COUPLINGS, HOSE AND FITTINGS

For better, faster service for users of fluid power equipment requiring replacement hydraulic components, the Anchor Coupling Co. Inc. consolidated catalog—No. D-2 describes the complete *replacement* line of Anchor Pressed-On Hydraulic Hose Assemblies, together with Anchor Reusable Couplings, Hose and Fittings. These Anchor products are carried in stock for immediate pick-up or delivery from Anchor distributors.

Prepared for quick reference, selection and ordering, catalog No. D-2 shows the comprehensive Anchor line of Pressed-On Hose Assemblies.

Anchor Super-Spiral Wire Reinforced High Pressure Hydraulic Hose Assemblies with Pressed-On Couplings, offering the highest burst and working pressures available in hydraulic hose assemblies, are completely described, with detailed specifications.

In addition, the new Catalog shows Anchor high pressure Pressed-On Hydraulic Hose Assemblies for extra strength Two Wire Braid, standard Three Wire Braid, and extra strength Three Wire Braid Hose.

Featured are Anchor's high pressure Two Wire Braid hose (SAE 100R2) assemblies with Pressed-On, Clamp-Type or Coverstrip Reusable Couplings, together with Anchor's medium and low pressure One Wire Braid (SAE 100R1) Assemblies with Pressed-On Couplings or Reusable Couplings. For non-flammable hydraulic fluids (Phosphate Esters), Anchor's High Pressure Two Wire Braid Hose Assemblies with Pressed-On Couplings are recommended.

Medium and low pressure One Wire Braid Cotton Cover Hose (Style QW-SAE 100R5) and One Wire Braid Rubber Cover Hose (Style QWR) Assemblies with Duloc Reusable Couplings are illustrated.

Described in detail are Anchor Max-Flo Hi-Burst Two Rayon Braid Hose (Style HR-SAE 100R3) and standard Style R Two Rayon Braid Hose Assemblies with Pressed-On, Clamp-Type and Reusable Couplings.

For suction, low pressure or gravity flow hydraulic lines, Anchor Max-Flo Spiral Wire Reinforced Suction Hose (Style SW-SAE 100R4) Assemblies with Pressed-On or Clamp-Type Couplings are shown.

Also illustrated are Anchor Style PR Rubber Cover 1-Cotton Braid Hose and Style PQ Cotton Cover 1-Cotton Braid Hose Assemblies with Anchor Hold-Fast Couplings for low pressure automotive, marine and industrial applications.

The Couplings section of Catalog No. D-2 gives detailed specifications for Anchor high, medium and low pressure Clamp-Type Reusable Couplings and Coverstrip Reusable Couplings for Two Wire Braid hose (SAE 100R2) and One Wire Braid Hose (SAE 100R1); DULOC Reusable Couplings for Style QW (SAE 100R5) and Style QWR hose; Reusable Couplings for Hi-Burst and standard Two Rayon Braid, Style HR (SAE 100R3) and Style R hose.

Described in detail are Anchor 4-Bolt Split-Flange "O" Ring Head Clamp-Type Couplings for use with the above mentioned hose. Also included are Anchor Split Flanges and components.

Anchor's Hold-Fast Reusable Couplings, in a wide variety of styles and sizes, are described.

The Anchor line of Adapter Unions, Adapters, Pipe Fittings and SAE Boss Fittings for hydraulic and industrial uses, with the largest variety of three combinations—standard, JIC, SAE, etc.—is included in the new catalog.

Copies of Anchor No. D-2 Catalog are available at Anchor distributors, or can be obtained by writing direct to Anchor Coupling Co. Inc., 312 North Fourth St., Libertyville, Illinois.

Circle 8 on Reader Service Card

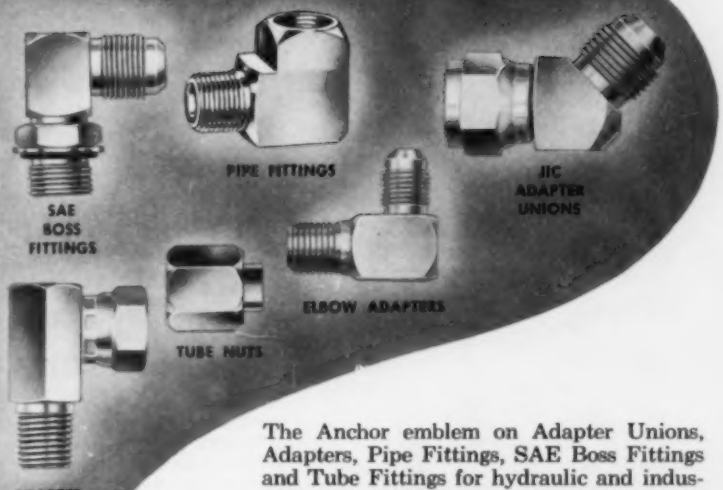
All Anchor FITTINGS carry this Emblem . . .

ANCHOR®

THE PLEDGE OF PERFORMANCE

the mark of

COMPLETE RELIABILITY



The Anchor emblem on Adapter Unions, Adapters, Pipe Fittings, SAE Boss Fittings and Tube Fittings for hydraulic and industrial uses signifies *complete reliability* . . . with all these Anchor products doing their job at peak efficiency.

These Anchor Fittings are precision-machined from bar stock and plated to prevent rusting. Space-and-trouble saving in their use, they have been for over 20 years, and are still, *first choice* for original equipment and replacements. Anchor Fittings . . .

- prevent hose strains caused by twisting during assembly . . .
- provide safer, more positive leakproof connections . . .
- make assembly easier in confined spaces.

There is an Anchor Fitting to meet all your specific needs . . . with the largest variety of thread combinations — standard pipe, JIC, SAE, etc.

Write today for the Anchor Catalog No. 206 showing Anchor Adapter Unions, Adapters, Pipe Fittings, SAE Boss Fittings and Tube Fittings . . . together with complete specifications.

Andy Anchor says:

"Call in a technically qualified Anchor field engineer to consult with you on any and all your hydraulic transmission line problems."

ANCHOR Coupling Co. Inc.

311 North Fourth St., Libertyville, Ill.

Branch Plants: Dallas, Tex., Plymouth, Mich.

Circle 9 on Reader Service Card

MARVEL
IN-LINE FILTER
CAPACITIES: Up to 60 G.P.M.
PIPE SIZES: ¾"—1"—1¼"—and 1½" (at both inlet and outlet).
BY-PASS VALVE: Available with or without.
Bonded LINE TYPE
CAPACITIES: 10—20—30—50 and 75 G.P.M.
PIPE SIZES: 1"—1¼"—1½"—2" and 2½".
BY-PASS VALVE: Available with or without.
OPERATING PRESSURE: Up to 250 p.s.i.
OPERATING TEMPERATURES up to 300° F.

QUALITY–DEPENDABILITY–EFFICIENCY

A simple formula—but is foremost in the design and construction of all Marvel Filters

—Over 900 O.E.M.s can't be wrong—

Designers and manufacturers of hydraulic equipment requested suction filters incorporating special features.

For example—a by-pass valve to assure instant flow of hydraulic oils on construction and earth moving equipment during cold weather operations. Three of the filters illustrated are available with this important feature.

The Tandem Sump Type Filter supplies the demand for a single unit to handle greater capacity where space limitations present a problem for multiple unit installations.

We are pleased to advise that all units are now stock items and are being supplied to many of over 900 Original Equipment Manufacturers who are installing them as standard equipment.

For Dependable Protection on all Hydraulic and other liquid circulating systems—Investigate MARVEL Synclinal Filters

For further information—write, wire or phone

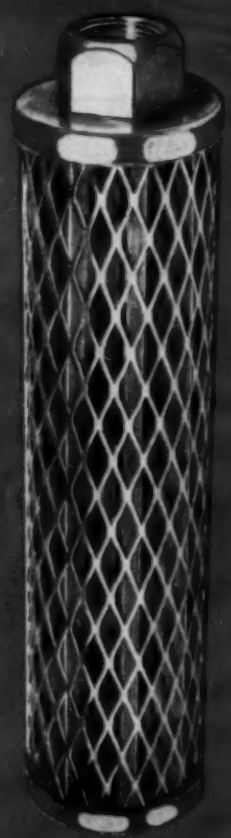
does it again!

Designers asked for these filters—

MARVEL is delivering them now!

Tandem SUMP TYPE

CAPACITIES: 10—16—20—40—60—100—130 and 200 G.P.M.
PIPE SIZES: ½"—1"—1¼"—1½"—2"—2½" and 3".
CONNECTIONS: Coupling—Male Nipple.
BY-PASS VALVE: Not available.



Bonded SUMP TYPE

CAPACITIES: 10—20—30—50 and 75 G.P.M.
PIPE SIZES: 1"—1¼"—1½"—2"—and 2½".
CONNECTIONS: Coupling—"O" Ring—Male Nipple.
BY-PASS VALVE: Available with or without.

MARVEL ENGINEERING COMPANY

7227 NORTH HAMLIN AVENUE, CHICAGO 45, ILL. • PHONE: JUniper 8-6023

Please send me information on Marvel Filters as indicated.

- ☐ Sump Type
- ☐ Line Type
- ☐ In-Line
- ☐ Tandem
- ☐ For Hydraulic Oil
- ☐ Fire Resistant Fluids
- ☐ For Coolants or Lubricants
- ☐ For Water

AH-4

*Name*_____

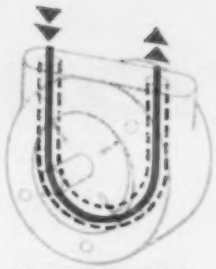
*Company*_____

*Address*_____

*City*_____ *State*_____

GAST rotary

AIR MOTORS
COMPRESSORS
VACUUM PUMPS



ALL GAST UNITS FEATURE THIS SIMPLE, DEPENDABLE ROTARY-VANE DESIGN

Gast offers you specialized experience in Air Motors, Air Compressors and Vacuum Pumps . . . for original equipment or plant use. The types and sizes shown, with selected accessories, will solve many application problems. All models feature rotary sliding-vane design for quiet, pulseless, positive air displacement. Vanes take up their own wear, maintaining high efficiency.

COMPRESSED AIR MOTORS

Model	Rpm.	Hp. At 60 Psig.	At 90 Psig.	Wt. Lbs.
1 AM	2,000	0.11	0.13	1½
	5,000	0.21	0.30	
2 AM	1,000	0.22	0.35	5½
	2,000	0.40	0.57	
4 AM	1,000	0.48	0.73	8
	2,000	0.78	1.10	
6 AM	1,000	0.80	1.30	17
	2,000	1.30	2.00	
8 AM	1,000	1.60	2.40	25
	2,000	2.80	4.20	
16 AM	1,000	2.70	4.20	65
	2,000	4.20	6.80	

BLACK = LUBRICATED RED = OIL-LESS MODELS

AIR COMPRESSORS

Model	Model No.	Hp.		Cfm.		Rec. Max. Press. Psig. Cont. Oper.		Rec. Max. Press. Psig. Inter-mittent		Net Wt.* Lbs.	
Integral (Motor Compressor)	0406	1/12	1/12	0.57	0.5	15	10	20	15	16	16
	0211	⅛	⅛	1.3	1.1	15	10	25	15	22	22
	0321	¼		2.3		20		25		25	
	0521	⅓		3.8		15		20		26	
Light-Duty	0240	¼	¼	1.9	1.9	10	10	20	10	8	7
	0440	⅓	¼	4.0	4.0	10	10	20	10	10	9
	0740	½	⅓	5.9	5.9	10	10	12	10	10	9
	1550	¾	¾	10.5	10.5	10	10	15	10	29	26
	3040	2	1½	30.0	24.0	10	10	15	10	68	60
Heavy-Duty Fan-Cooled	0465	½		4.0		25		30		18	
	0765	½		5.9		10		15		18	
	1065	1		8.3		25		30		33	
	2065	1½		17.0		15		20		52	
	2565	2		21.0		15		20		51	
	4565	5		45.0		15		20		92	

*Weight without base or motor, except integral models.

VACUUM PUMPS

Model	Model No.	Hp.		Cfm.		Rec. Max. Vac. "Hg Cont. Oper.		Rec. Max. Vac. "Hg Inter-mittent		Net Wt.* Lbs.	
Integral (Motor Pump)	0406	1/12	1/12	0.57	0.5	15	10	25	20	16	16
	0211	⅛	⅛	1.3	1.1	15	10	27	20	22	22
	0321	¼		2.3		28				27	
	0521	⅓		3.8		28				28	
Light-Duty	0240	¼	¼	1.9	1.9	15	20	26	24	9	10
	0440	¼	¼	4.0	4.0	15	20	26	24	11	12
	0740	½	½	5.9	5.9	10	20	26	24	11	12
	1550	½	½	10.5	10.5	15	20	25	24	29	30
	3040	1½	1½	30.0	24.0	15	20	27	25	68	66
Heavy-Duty Fan-Cooled	0465	⅛		4.0		28				18	
	0765	½		5.9		28				18	
	1065	½		8.3		28				33	
	2065	1		17.0		28				54	
	2565	1½		21.0		28				53	
	4565	3		50.0		20		28		92	

*Weight without base or motor, except integral models.

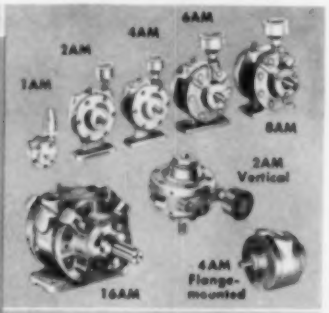
MINIATURE OIL-LESS • COMPRESSOR • VACUUM

Model	Wt., Lbs.*	Hp.	Type Drive	Pump Rpm.	Cfm.	Press. Psig. Cont. Oper.	Max. Vac. " Hg Cont. Oper.
0330	3.2	1/40	direct	3450	.35	10 psig.	20
0630	9.2	1/12	direct	3450	.6	20 psig.	24
1030	9.2	1/12	direct	3450	1.0	10 psig.	20

*with base and motor

1/20 TO 7 H.P.

GAST AIR MOTORS are explosion-proof and variable in speed. Built with either right or left-hand rotation—also in reversible models. They are amazingly compact . . . light in weight for h.p. delivered . . . and low in cost. They'll start in any position . . . can't burn out from overloads or stalling. Rotor vanes take up their own wear, maintaining "like-new" efficiency. Offered with foot (base) or flange-type mounting . . . and for horizontal or vertical position.



.6 TO 45 C.F.M.

INTEGRAL MOTOR-PUMPS — Compact, light weight, efficient "packaged" units. Compressor rotor mounted on motor shaft. Pulseless air delivery.

LIGHT DUTY — For intermittent service. Positive displacement. Resemble heavy-duty models, less fans or deep cooling fins (not needed for brief operating periods). Simpler lubricator.

HEAVY DUTY — Fan-cooled for continuous operation. Rotary design — maximum air per lb., per h.p. Automatic lubricator has self shut-off when unit stops.

.6 TO 50 C.F.M.

INTEGRAL MOTOR-PUMPS — Compact, light weight units save mounting cost and time. Excellent for portable equipment. Rotor mounted on motor shaft.

LIGHT DUTY — For intermittent service. Quick pick-up, trouble-free performance. Resemble heavy-duty models, less fans or deep cooling fins. Simpler oiler.

HEAVY DUTY — Forced air fan-cooled for continuous service, trouble free dependability. Deep cooling fins. Lubricator has built-in automatic shut-off.

.3 TO 1 C.F.M.

MINIATURE OIL-LESS PUMPS — (Larger oil-less models shown in red above.) 3 typical models shown here. Quality rotary sliding-vane construction. Other motors available: 1/25 & 1/20 h.p.

Original Equipment Manufacturers for Over 30 Years

GAST MANUFACTURING CORP.
Air Motors • Vacuum Pumps • Compressors
P.O. BOX 117-D, BENTON HARBOR, MICHIGAN

WRITE TODAY for "Application Ideas" Booklet, Gast Catalog or Model Data Sheets. Our engineers will gladly assist you. "Air may be your Answer!"

. . . Fluid Power news

OILGEAR 40 Years of Fluid Power

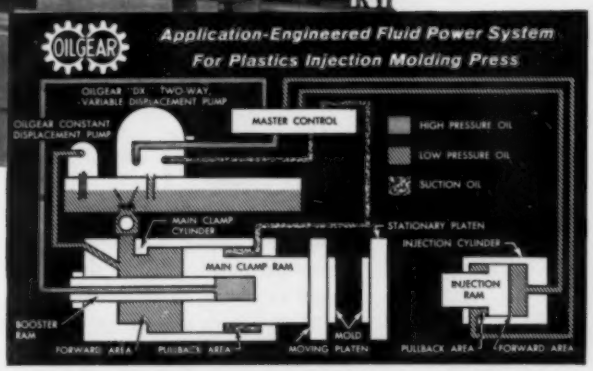
Report No. 11,602 From Oilgear *Application-Engineering* Files

HOW OILGEAR ENGINEERING TEAMWORK AIDED DESIGN OF NEW INJECTION MOLDING MACHINES

CUSTOMER: *National Automatic Tool Co., Inc. (NATCO), Richmond, Indiana*

DATA: As a preliminary guide to design and production of a new line of injection molding machines, "NATCO" engineers used a 31-question survey of molders operating eight or more machines. This survey confirmed "NATCO" engineers' experienced opinion that: 1. Most unplanned downtime on injection molding machines was due primarily to hydraulic system problems . . . shocks caused by sudden shifts in pressure or direction of flow through valves "under pressure," causing pipe and welded joint fatigue, bent valve stems, cracked or over-stressed tie-rods and cylinders. 2 Molders' demands for higher speeds and pressures further amplify these problems. *Basic "NATCO" Requirements:* 1. A hydraulic system to eliminate shock, hammering, and the resulting costly downtime . . . must provide continuous, dependable, high-speed operation. 2. Both slow and high-speed closing, as well as two-speed injection control for faster molding cycles. 3. High-speed clamp action. 4. Precision control of speeds and pressures to insure high molding quality. 5. Must be a "clean" package . . . compact, leak-free, simple to install, fast and easy to maintain, quiet, conserve electrical power.

New "NATCO 400" Plastics Injection Molding Machine — one of four standard sizes. Note overhead position of the Oilgear pump and reservoir . . . away from dirt and molding-room traffic. This position permits fast gravity flow of oil from the reservoir through a prefill valve into the large clamp cylinder to speed operation. During the past year . . . a period of unusually low capital investment purchases . . . over 150 Oilgear Pumps have been put into operation on this new "NATCO" line.



Simplified schematic illustrates one phase of system operation — high-speed closing of clamp ram. Large clamp cylinder is being gravity-filled through prefill valve, while mold clamp is being advanced by small booster cylinder powered by Oilgear "DX" pump. Closing speed — 700 in./min. This circuit design provides clamp pressure build-up in a fraction of a second . . . one of the reasons for the fast cycles on the "NATCO 400."

SOLUTION: Cooperation and teamwork between "NATCO" and Oilgear engineers resulted in a new, shockless, *Fluid Power* System . . . basis of a revolutionary new line of high-speed, high-capacity, plastics injection molding machines. This system incorporates two Oilgear Pumps . . . one, a large capacity, radial piston, two-way, variable displacement type "DX" pump with remote electric control which alternately serves the mold clamp and injection rams; and a small capacity, constant displacement type "HG" pump which maintains a high, positive clamping force during injection cycle. Instead of using conventional valves "under pressure" to reverse clamp and injection rams, these functions are accomplished by reversing fluid flow in the Oilgear type "DX" pump. With this system, flow and pressure decelerates to zero *before* flow direction is changed . . . flow then accelerates to a preselected volume in the new direction — completely eliminating reversal shocks. No chokes or other controls on the master valve are necessary, as diverting of flow from clamp to injection rams is also made under ideal "no-flow" conditions, with absolutely no shock. Infinitely variable machine speeds are obtained by varying pump stroke, resulting in a minimum of heating and horsepower dissipation.

For similar practical solutions to YOUR linear or rotary Controlled-Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

1564 WEST PIERCE STREET MILWAUKEE 4, WISCONSIN

"NATCO," famous in machine tool and plastic molding machine fields, states — *"Although lower priced pumps could be secured, they basically did not offer the control features found in the Oilgear units. This is especially true of the larger capacity pump, which in addition to its variable and reversible features incorporates many auxiliary controls. It's more than just a pump . . . it contains auxiliary systems for pilot, supercharge, cooling, safety, and filtering. These pumps are quiet. They have an excellent injection molding machine service record . . ."*

FLUID POWER LINES

from editor to reader

IDEAS . . . INITIATIVE . . . INGENUITY

One of the pleasant things about being a magazine editor is the interesting mail you receive. Not long ago this unusual letter arrived from an African lad of 15. We think it's worth your reading, because it exemplifies the characteristics that are so necessary for a successful business—whether you're selling hydraulic presses, fluid power components, or snakeskin slippers.

> Dear Editor,
>
> Your name and address was favoured to me through one of my mates as one of the reliable editors in the Cleveland, Ohio of yours and taking this opportunity, I hasten to communicate with you.
>
> For your information, I am a boy, aged 15. I am five feet five inches tall with brown complexion and dark black hair. My hobbies are reading, swimming, fishing, football, and table tennis.
>
> I will be very much obliged if you can publish my name and address in your Industrial Publishing newspaper as an African boy interested in friendship with Cleveland Ohio of your area.
>
> With regards exchange some goods I exchange some of the Nigerian products such as ebony carvings, raffia bags, animal skin bags, snakeskin slippers, wallets, African combs, sun hats, dagger knives, native caps, decoration articles, etc. in exchanging for American goods such as sport shirts, jeans, dollars, cameras, shoes, handwatches, etc.
>
> I shall be pleased to hear in return that you have published me, then I will be very happy, then I will be expecting letters from interested friends.
>
> I am living in Lagos which is the capital of Nigeria.
>
> Thanks in advance, Rauphew Shittu

Our first reaction to this letter was a benign smile and nostalgic memories about the adventurous schemes of 15-year-old boys. But then something more important became apparent. This imagination, this initative, this ingenuity is the key to success in all business operations. Creative design, creative selling, creative production and management—these are the goals all of us must be striving for to advance our economic positions. How do you become creative? Some of it must be inborn, but much of it you must learn.

That's where a technical magazine like this one can be of value. We try to emphasize the design and production *ideas* of each fluid power application that we present. We want these to stimulate *your* imagination so that you can apply them to *your* equipment.

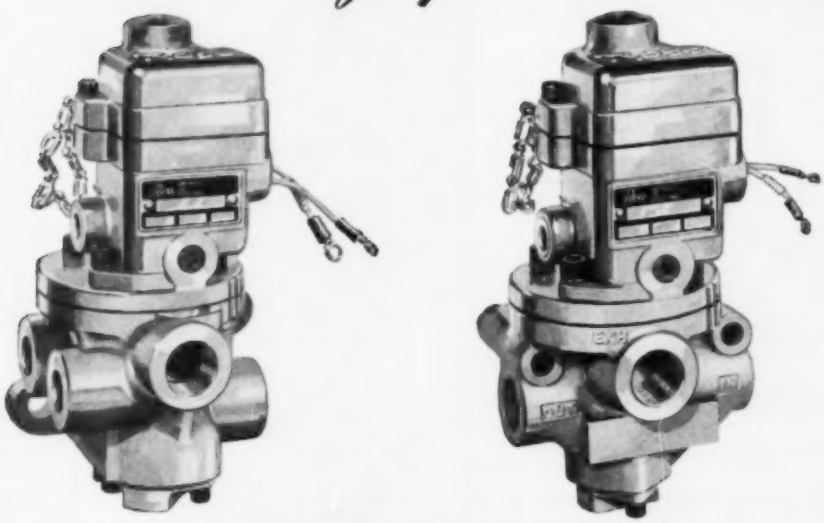
With this issue we've introduced a new department called *Fluid Power At Work.* We'll fill it each month with news about where hydraulics and pneumatics is finding new uses, and how it's doing jobs better than ever before. You'll find plenty of ideas there, and in the feature articles following. They're yours for the reading. And if you're in the market for raffia bags or sun hats, write me for the address.

Allan E. Morris

THANK YOU . . .
for your enthusiastic response to this announcement. Because it has been viewed as an important advance in valve development, we reprint this news for those who missed its first appearance.

Ross

Proudly presents



THE NEW "HEADLINE" SERIES

A complete new series of inline valves, sizes one-quarter inch through one and one-half inch, straightway, 3-way and 4-way. These valves, size for size, will operate faster, longer, and provide greater capacity than any other valves we have been able to find.

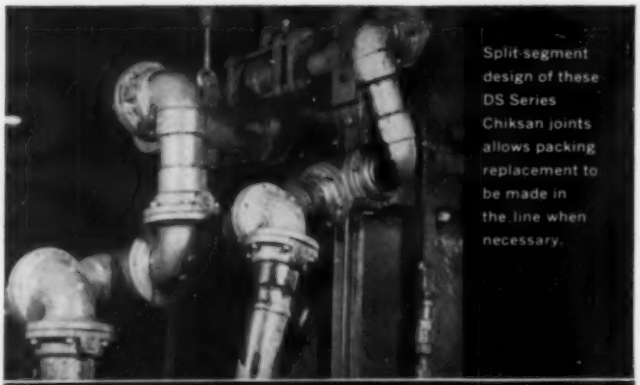
When the price, quality and performance and Ross reputation are taken together in evaluating this series, it represents probably the best valve value available today. Before you specify any valve after today, you owe it to yourself to look into the "Headline" series. Write for full information.

Ross OPERATING VALVE COMPANY
105 EAST GOLDEN GATE AVE. • DETROIT 3, MICHIGAN

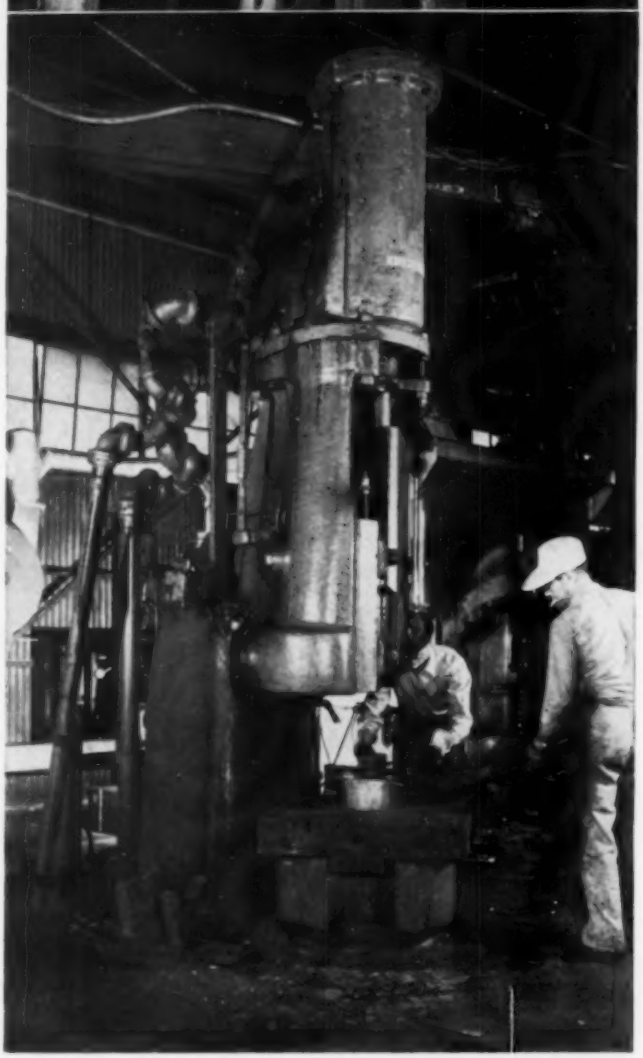
DESIGN SAFE, DURABLE FLEXIBILITY INTO YOUR LINES with CHIKSAN SWIVEL JOINTS

Whenever you apply Chiksan swivel joints, you get a line that lasts longer and reduces maintenance costs for years to come. Flexing in predetermined arcs, Chiksan joints eliminate common causes of line failure due to tight bends or torsional fatigue. Wherever certain designs require wide hose loops, Chiksan joints permit shorter, more compact lines. In fact, wherever fluid or air lines require flexibility, Chiksan swivel joints can provide a direct and lasting benefit.

Chiksan joints are available from stock in a wide range of materials, temperatures and pressures, to meet practically every design requirement. Write Chiksan Company, Brea, California, today for a catalog and the name of the representative in your area.



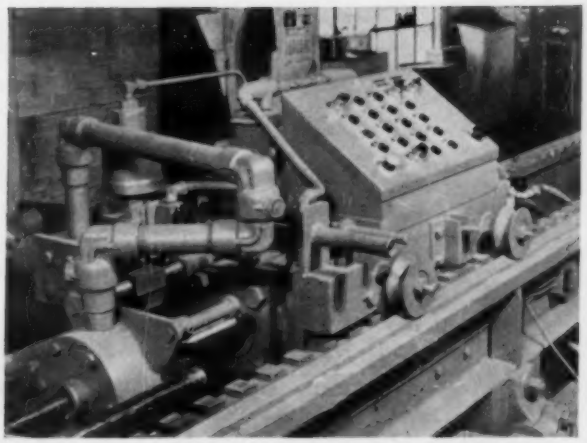
Split-segment design of these DS Series Chiksan joints allows packing replacement to be made in the line when necessary.



SHOCK, HIGH PRESSURE STEAM DOESN'T FAZE THESE CHIKSAN JOINTS – A 2000 pound dropforge with high pressure steam sets up a rough set of service conditions. These Chiksan swivel joints replaced flexible metal tubing which was going out in two and three weeks. Joints have been in service for over five months and customer reports good service to date, expects years more.

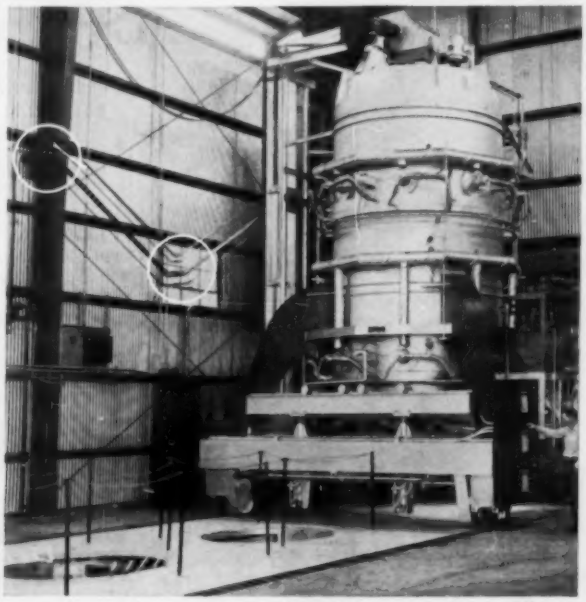
SEND FOR YOUR COPY OF THIS COMPREHENSIVE AND INFORMATIVE SWIVEL JOINT CATALOG.

FLEXIBLE CHEMICAL LINES? CHIKSAN HAS THE ANSWER—Providing needed safety for a loading arm to handle sulfuric acid (as this Chiksan joint is doing) or most any chemical is an everyday occurrence with Chiksan joints. Over 2000 different types, styles and sizes in a variety of temperature and pressure ratings are available for your design needs.



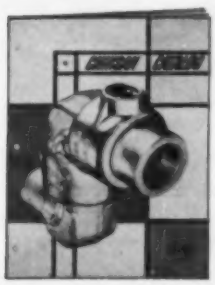
RUPTURE PROOF LINES FOR HIGH PRESSURE HYDROTESTING—Critical lines take on a new measure of safety with these flexible steel swivel joints. In service on a pipe testing machine, these lines receive up to 1000 pounds of pressure and more every five seconds as lengths of new pipe move through the testing machine. Only occasional service is required to keep these joints in top working condition.

SWIVEL JOINTED JUMPER SYSTEM SOLVES MANIFOLD PROBLEMS—Moving large quantities of differing liquids from barge to storage tanks posed a problem. A closed system wasn't practical because of contamination due to leakage or accidental opening of a valve. Use of a Chiksan swivel jointed jumper system provided a solution that eliminated cross contamination.



CONSTANT FLOW CHARACTERISTICS ALLOW PRECISE CONTROL—Heat treating furnaces require exacting temperature control. Previous experience with flexible hose indicated too much variation in flow characteristics. By using swivel joints and metal piping, company engineers were able to design a supply line system that insured desired control.

#60-54



fmc **CHIKSAN** COMPANY • 330 NORTH BREA BLVD., BREA, CALIFORNIA

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Please send me a copy of your latest catalog.

Name_____ Company_____

Title_____ Address_____

City_____ Zone_____ State_____

NEW YD-SERIES
DOUBLE-ACTING, 10,000 P.S.I.
50, 75, 100, 150 TONS, HEAVY DUTY
BORES: 3¼", 4½", 5⅛", 6⅛"

NEW YDS-SERIES
DOUBLE-ACTING
10,000 P.S.I., 8, 15, 25 TONS
BORES: 1½", 2", 2½"

CENTER HOLE

NEW YDT-SERIES
DOUBLE-ACTING
10,000 P.S.I.
17, 30, 50 TONS
BORES: TWO 1½", TWO 2", TWO 2½"

CENTER HOLE

Y-SERIES
SPRING RETURN
10,000 P.S.I.
17½, 30, 50, 100 TONS

YS-SERIES
SPRING RETURN
7-9,500 P.S.I.
2, 4, 7, 10, 20, 50 TONS

New OTC 10,000 p.s.i. Hydraulic Cylinders

- PRECISION BUILT, POWERFUL, COMPACT, LIGHTWEIGHT
- THE FIRST ADVANCES FROM OTC'S NEWLY FORMED "PRECISION HYDRAULICS DIVISION"

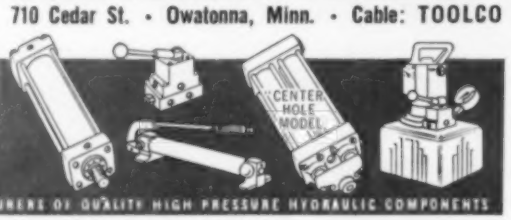
OTC 10,000 P.S.I. hydraulic cylinders open new possibilities in "hi-pressure" designing by meeting high force requirements with compact, lightweight components. Cylinders are precision built for dependable, continuous performance. Choice of stroke length and standard or tie-rod extension mountings for YD, YDS and YDT series cylinders. Requests for quotations invited.

New two-stage and single-stage 10,000 P.S.I. hydraulic pumps and power packages also available.

WRITE FOR FREE ENGINEERING DATA FILE CATALOG

PRECISION HYDRAULICS DIVISION
OWATONNA TOOL CO.
710 Cedar St. • Owatonna, Minn. • Cable: TOOLCO

RESEARCH · ENGINEERING · DEVELOPMENT
OTC



DESIGNERS AND MANUFACTURERS OF QUALITY HIGH PRESSURE HYDRAULIC COMPONENTS

Circle **93** on Reader Service Card

LETTERS to the editor

Address your letters to: The Editor, HYDRAULICS & PNEUMATICS MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

Mobile equipment instruction

TO THE EDITOR:

I am teaching a course at Wayne State University. We are now at the stage where we could use your September 1960 issue as source material for special problems given to the students. All fifteen members of the class are employed in some phase of mobile hydraulic power applications. Please send me a copy for each.

JOHN J. SCHERER
Applied Management & Technology Center
Wayne State University
Detroit

We are very pleased that you find the Mobile Equipment Issue of value as educational source material. Copies have been sent.

Radiation effects

TO THE EDITOR:

I need information about effects of radioactivity on components and on fluids. I would appreciate your passing on any knowledge you have of the whereabouts of such information.

RONALD C. GYLES
Electrical Engineer
Perfecting Service Co.
Charlotte, N. C.

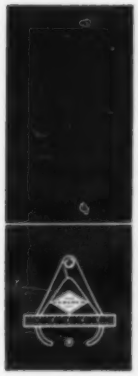
As you may know, this is an area of investigation in many of the missile and spacecraft programs. I suggest you contact Mr. B. R. Teree, chairman of the SAE A-6 Committee (Aero-Space Hydraulic & Pneumatic Systems & Equipment). Perhaps he can point out investigations on this subject.

Marine hatch covers

TO THE EDITOR:

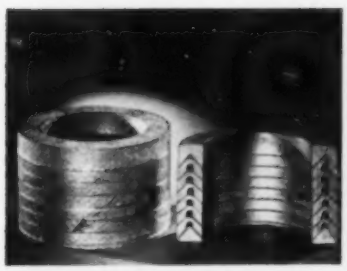
I recently had the opportunity of reading the February 1960 issue of your publication dealing

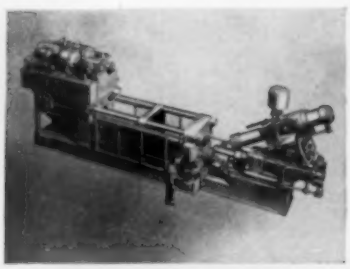
Continued on page 16



ENGINEERED PACKINGS

for Hydraulic, Pneumatic Service





Wherever fluid power is used, Garlock CHEVRON* Packings (upper left) stop leakage, increase efficiency . . . on heavy industrial apparatus like this plastics injection molding machine (upper right), construction equipment such as road graders (lower left) and tractor shovels (lower right).

Design to include Garlock CHEVRON Packings on your hydraulic-pneumatic application. Others have, and are enjoying a longer lasting, more positive seal than ever before.

At all pressures, CHEVRON Packings provide low-friction, leak-proof operation. Designers find them ideally suited for use on single and double-acting hydraulic cylinders, hydraulic rams, plungers of pumps and other reciprocating rods.

Flexible and sensitive to pressure change. Garlock CHEVRON Packings employ an exclusive hinge-like construction. When the pressure is on, the packings tighten to prevent leakage. When the pressure declines, the packings maintain a tight seal but ease off to allow the rod or ram to return without binding. CHEVRON Packing Rings provide adequate heel clearance for easy installation. Once installed, further gland adjustment is rarely, if ever, necessary to compensate for pressure changes. Garlock CHEVRON Packings work very efficiently in shallow stuffing boxes. Apply them against water, steam, oil, gases and chemicals in temperatures to +600°F.

For hydraulic-pneumatic service of all types, Garlock offers a complete line of products. *Garlock "O" Rings* for static and dynamic applications . . . *Garlock* CHEVRON *Rings* for rod and stuffing box seals on reciprocating applications . . . *Garlock Cup Packings* for hydraulic-pneumatic, low friction service.

Find out more about the many materials and sizes of Garlock Hydraulic-Pneumatic Packings. Call your Garlock representative at the nearest of the 26 Garlock sales offices and warehouses throughout the U. S. and Canada. Or, write for Catalog AD-115 (CHEVRON Packings), AD-148 ("O" Rings), and AD-189 (Cups). Garlock Inc., Palmyra, New York.

GARLOCK

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Co.

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*REGISTERED TRADEMARK

LONGER-SERVICE
HOSE ASSEMBLIES FOR
EVERY REQUIREMENT
STRATOFLEX
HOSE & FITTINGS
OIL & FUEL ASSEMBLIES ON A DIESEL ENGINE
HYDRAULIC ASSEMBLIES ON A MINING MACHINE
AIR BRAKE ASSEMBLY ON A TRAIN
FREON ASSEMBLIES ON AN AUTO AIR CONDITIONER

VIBRATION PROOF • LEAK PROOF • ABRASION RESISTANT

Manufacturers and users of equipment requiring hose assemblies can depend on Stratoflex flexible hose and hose fittings to reduce downtime through availability, thereby holding maintenance costs to a minimum. Designed for diesel, automotive, general industrial and commercial applications, Stratoflex hose and fittings have the proven durability that is necessary for dependable service. Stratoflex hose and fittings are available in a wide variety of sizes and types to meet every requirement. Shown above are typical installations where Stratoflex hose and fittings are giving economical, dependable service.

For complete information, write for S-2 bulletin. SF1-1

STRATOFLEX Inc.

P.O. Box 10398 • Fort Worth, Texas
Branch Plants: Hawthorne, Calif., Fort Wayne, Ind.
In Canada: Stratoflex of Canada, Inc.
In Great Britain: Stratoflex (U.K.) Ltd.

SALES OFFICES:
Atlanta, Chicago
Cleveland, Dayton
Detroit, Fort Wayne
Fort Worth, Hawthorne
Houston, Kansas City
Milwaukee, New York
Orlando, Philadelphia
Pittsburgh, San Diego
San Francisco, Seattle
Toronto, Tulsa

Circle **114** on Reader Service Card

LETTERS

with applications of hydraulics on board ships. In the article describing side port hatches on page 61, I would like to know sizes, whether they are acceptable to Lloyds Register of Shipping and whether these doors have been designed to open inboard as well as outboard as shown.

In the article, *Self-Sequencing Circuit Lifts Hatch Covers*, the principle of opening and shutting hatch covers is very good. I will possibly have a similar problem soon, and would appreciate information about the manufacturer so that I can contact him for sizes and other information.

K. M. MURRAY
Repairs Superintendent
Union Steam Ship Co.
of New Zealand, Ltd.
Sydney, Australia

For information about the side port hatches we suggest you contact Mr. H. R. Glennon, Jr. Vice President Moore-McCormack Lines. This company installed these hatches on their S. S. Argentina and S. S. Brasil. We have also sent you the name of a manufacturer of side hatches and the hatch cover manufacturer you inquired about.

Want to reproduce H&P Diagrams

TO THE EDITOR:

In your issue of November 1959 there was a short article on transfer mechanisms illustrated by several line diagrams. I would like to include two or three of these diagrams in my book on recent developments in production technology—in the chapter on transfer mechanisms. I assume that you own the copyright, and I am therefore writing to ask you permission to reproduce these diagrams. The appropriate acknowledgements will be gladly made.

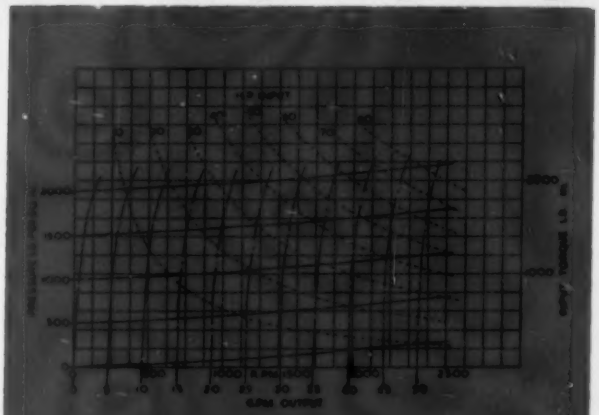
D. E. GREENE
Lecturer
Northampton College of Adv. Tech.
London, England

You have our permission to reproduce diagrams from the article by Raymond Dipple. ▼▼▼

KEELAVITE Hydraulics

GEAR PUMP / MOTORS

One of the new heavy duty gear pump/motors designed for high continuous rating.



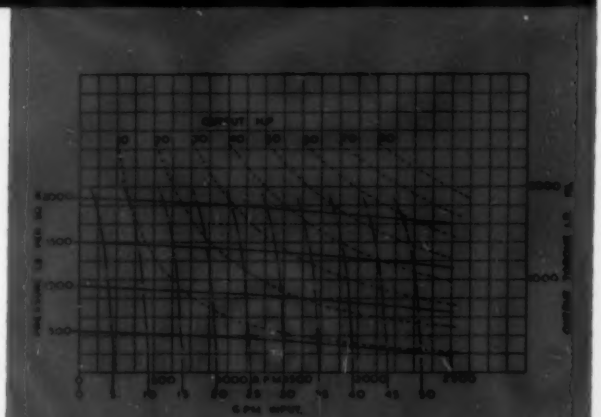
G221 GEAR PUMP

KEELAVITE GEAR PUMP/MOTORS

Within the wide range of the KEELAVITE G SERIES of GEAR PUMP/MOTORS, there is a unit suitable for any industrial use. Used as pumps, output ranges from 2.25 gpm. to 180 gpm. Motor torque ranges from 10.5 lb. ins. per 100 psi to 785 lb. ins. per 100 psi.

WHY THEY ARE BETTER

All of the KEELAVITE PUMP/MOTORS conform to a high standard of workmanship in manufacture, and are reversible without alteration in assembly. The whole range stems from six basic sizes and common components are used within each basic size. All units incorporate roller bearings.



G221 GEAR MOTOR

TYPICAL PERFORMANCE CURVES OF THE KEELAVITE G221 GEAR UNIT

THE RECOGNISED AUTHORITY ON HYDRAULIC POWER TRANSMISSION

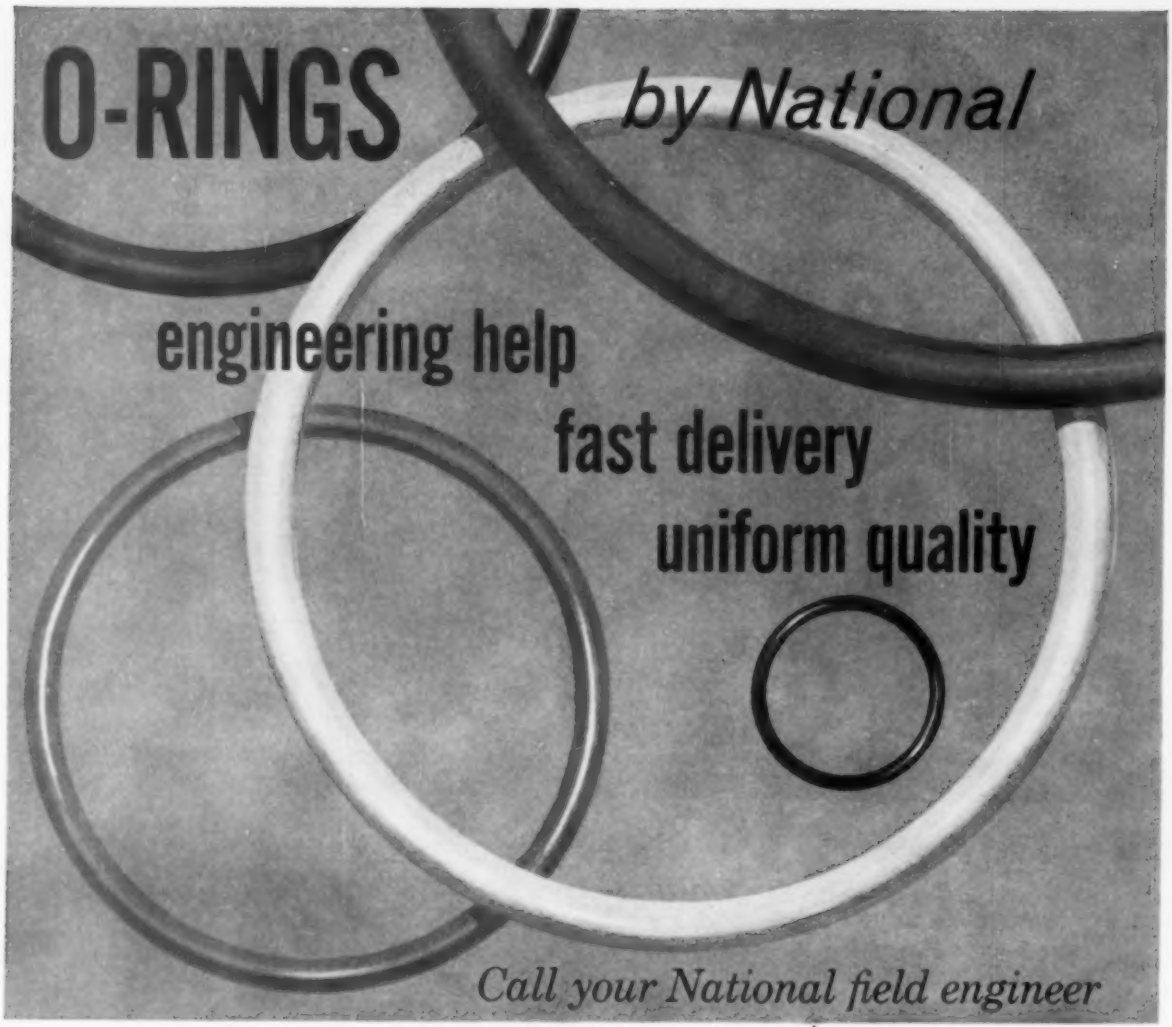
For full details write to—

KEELAVITE Hydraulics

EUROPEAN REPRESENTATIVE
Mr. T. P. Keeling,
Keelavite Hydraulics Ltd.,
Pieter de Hoochstraat 17
Rotterdam 6,
Holland

KEELAVITE HYDRAULICS LTD, ALLESLEY, COVENTRY, ENGLAND

Telephone: Meriden 441



National O-Rings are precision made, uniform industrial rings available throughout the United States—promptly! Quality is superior; all ingredients are inspected before compounding and compounding is strictly controlled for maximum uniformity. Molding is done on modern equipment by veterans of 20 years in O-Ring manufacture. Every precaution is taken to insure that no O-Rings with cuts, scratches or mold defects are shipped.

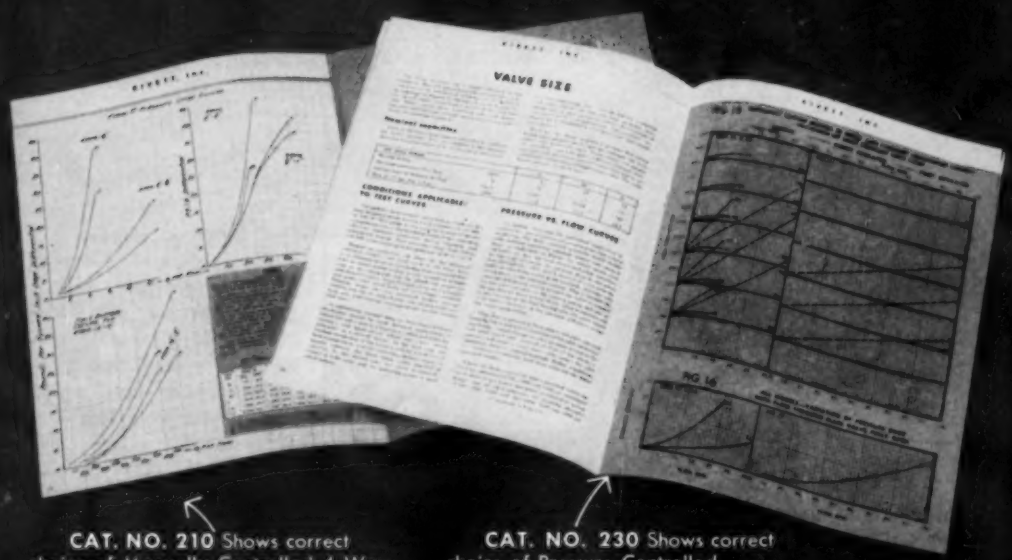
NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

Atlanta 8, Georgia
George W. Smith Company
3130 Maple Dr., N.E.
JAckson 233-7383
Chicago (Franklin Park) Illinois
10013 West Grand Ave.
GLadstone 5-4420
Cleveland 18, Ohio
210 Heights Rockefeller Bldg.
3091 Mayfield Road at Lee
YEllowstone 2-2720
Dallas 19, Texas
Benson Engineering Company
2514 West Mockingbird Lane
FLeetwood 2-7541
Detroit 27, Michigan
13836 Puritan Avenue
VErmont 6-1909
Indianapolis 5, Indiana
2802 N. Delaware St.
WAlnut 3-1535
Kansas City (Prairie Village) Kansas
Benson Engineering Co.
2106 West 75th
ENdicott 2-2843
Los Angeles (Downey) California
11634 Patton Road
TOpaz 2-8163
Milwaukee 4, Wisconsin
647 W. Virginia Street
BRoadway 1-3234
Montreal, Quebec
Merrill-McLean Company, Ltd.
45 Seigneurs St., WEllington 5-5075
Red Bank, New Jersey
16 Spring Street
SHadyside 7-3242
Wichita, Kansas
Benson Engineering Company
519 So. Broadway
AMhurst 2-6971

5600-R

STOP GUESSING VALVE PERFORMANCE!



CAT. NO. 210 Shows correct choice of Manually Controlled 4-Way Hydraulic Valves

CAT. NO. 230 Shows correct choice of Pressure Controlled Hydraulic Valves

RIVETT Publishes The Facts So You Can Predict Accurately Pressure Drop In 4-Way and Pressure Controlled Hydraulic Valves!

Select your valves on facts, not guesses! The flow versus pressure drop curves shown in the catalogs above are based on actual tests. The curves make it possible to determine system efficiency and operating costs *before* you operate the circuit. Rivett's lower pressure drop means a lower cost to actually run your hydraulic systems. Before you specify the components for your next system, get the facts! Ask your Rivett dealer, or write for Rivett Catalogs 210, 230, 250 and 261 now.

RIVETT

Furnishes Complete Line of Hydraulic Valves — Over 400 Standard Models — 1500, 2000, 3000 P.S.I.—Sub-Plate and Pipe Mounted—¼" to 1½" Sizes—3 G.P.M. to 130 G.P.M.

FLOW CONTROL
Model 8622: 3000 P.S.I.; Sub-Plate Mounted. Four Sizes: ¼" to 1½". See Catalog 250.

PRESSURE CONTROL
Series 8800: Relief, Sequence, Unloading, Reducing, and Counterbalance. With and without check. See Catalog 230.

MANUAL CONTROL
Series 5000 and 6100: 4-Way. Hand, Foot, or Cam. Sub-plate or Pipe Mounted. ¼" to 2" sizes. 2000 and 3000 P.S.I. See Catalog 210.

SOLENOID CONTROL
Series 6300 and 6600: 4-Way, Direct or Pilot operated. ¼" to 1½" in three basic sizes. 3000 P.S.I. Low current. See Catalog 261.

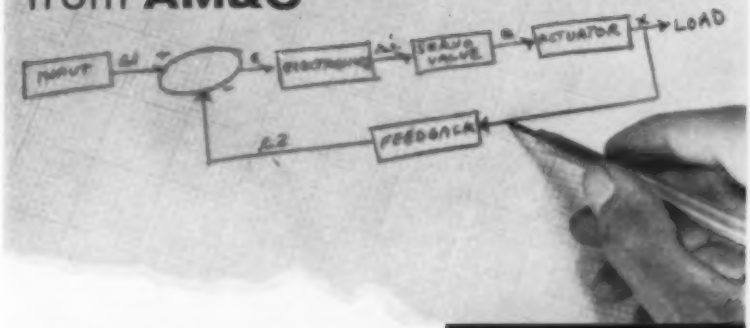
PILOT CONTROL
Available in Solenoid, Pressure and Manual operations. ¼" to 1½" sizes. 1500, 2000 and 3000 P.S.I.

RIVETT

RIVETT, Dept. HP-4, Brighton 35, Boston, Mass.
furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS
Member — National Fluid Power Association

close the loop . . with ELECTRO-HYDRAULIC SERVO COMPONENTS . . from AM&C



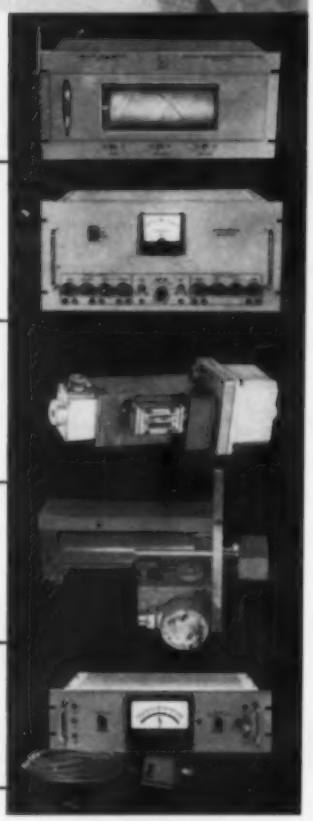
INPUT → *Model 750 Analog Programmer* — Generates a voltage corresponding to an arbitrary function drawn on graph paper: ramp, sine, square and triangular function generators also available.

ELECTRONICS → *Model 601 Servo Amplifier* — Provides summing, amplification and feedback circuitry for driving any electro-hydraulic servo valve. Other standard and special AC or DC amplifiers and demodulators also available.

SERVO VALVE → *Model 244 Electro-Hydraulic Servo Valve* — 0-50 gpm, 3000 psi valve designed for rugged, industrial use. Incorporates powerful, long-life *Model 104 Torque Motor*. Other servo valves available from 0-1 to 0-400 gpm and to 5000 psi system pressure.

ACTUATOR → *Model 500 Hydraulic Actuator* — Completely instrumented. Can incorporate servo valve manifold, filters, solenoids, overload protection, AC or DC feedback devices. Other linear or rotary hydraulic actuators can also be supplied.

FEEDBACK ← *Model 690 Dynamic Position Meter* — Provides feedback voltage and readout as a function of load position. Other feedback units available for sensing pressure, flow, force, velocity, attitude and other parameters.



AM & C can provide *all* of the elements for successful servo control — from the engineering and production of unique electronic, electro-hydraulic and electro-mechanical components to complete integrated system "packages" to do a specific job. If your problem involves instrumentation or automatic control of position, speed, pressure, flow, or force, our engineers can assist you. Telephone or write:

AMC AND

AMERICAN MEASUREMENT & CONTROL, INC.
Subsidiary of CompuDyne Corporation
WALTHAM 54, MASSACHUSETTS
TWinbrook 4-6212

Circle **6** on Reader Service Card

FLUID POWER FORUM

Each month HYDRAULICS & PNEUMATICS surveys readers for their experiences and opinions in fluid power design.

When you needed a special purpose valve (hydraulic, pneumatic, water, servo, cryogenic, hot gas, etc.) were you able to buy it? Did you have to modify a standard valve, or did the manufacturer do it for you? What modifications were made?

Those valves which I have selected for use in various systems have always been the standard catalog items carried by various manufacturers. When a special requirement occurs, it has been my experience that the time delay to obtain the special valve is excessive and the cost is prohibitive. These two factors have always caused a re-evaluation of the job and system with the intention of using standard catalog items to perform the required functions. To date we have always been successful in this approach without compromising function, service, or reliability.

H. C. FRIESS
Designer
Chance Vought Aircraft Corp.
Dallas, Texas

In general, we try to use commercial components without modification if they meet our standards, for use in missile GSE. There are many instances, however, when specifications require modification of, or design of a new component. In most cases I have found that both approaches lead to many hours of test and debugging before the component will meet specifications. This is true whether the commercial vendor does the redesign work or our company does it. Since we recently established a hydraulic test laboratory in our Stamford facility, I am certain we

Continued on page 22

another PRODUCT LINE *from* Modernair ® Trademark

SERIES TA *and* TH

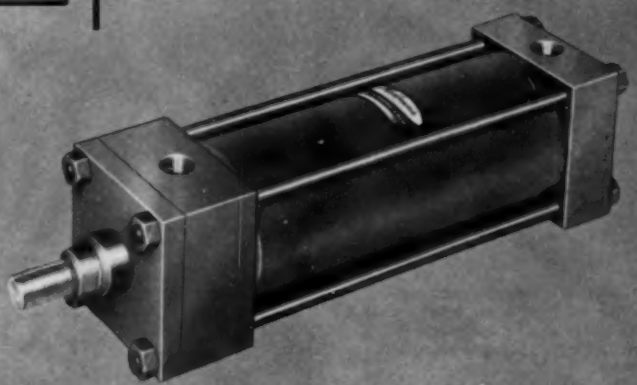
HEAVY DUTY CYLINDERS

SERIES TA — for air service to 200 psi

SERIES TH — for hydraulic service to 2500 psi

Modernair's TA series is specifically designed to meet the need for a rugged, reliable low pressure (200 psi) air cylinder with exceptionaliy long service life under heavy mill-type operating conditions.

TH series cylinders are designed for heavy duty hydraulic service at pressures from 500 to 2500 psi.



FEATURES

* Meet or exceed applicable JIC standards.
* Piston rods of heat-treated alloy steel, chrome plated and polished, with wrench flats.
* Lip-type piston packing; synthetic wear-compensating rod wipers; boots available.
* Series TA heads of aluminum alloy; TH heads machined from cold-rolled steel.
* Series TA barrels of seamless brass tubing ⅛" wall thickness; Series TH barrels are honed steel.
* Available in 1½", 2", 2½", 3¼", 4", 5" and 6" bore sizes, all popular mountings.

TH Series Operating Pressures

Bore Size	PSI Hydraulic Operating Pressure		
	Heavy Duty Service	Non Shock Service	4:1 Safety Factor
1½	1500	2500	1500
2	1500	2500	900
2½	1000	1500	500
3¼	1500	2500	950
4	1000	1500	600
5	800	1200	450
6	800	1200	500

Whenever you have a tough application where reliability, long service life and minimum down-time for maintenance are vital factors, it will pay you to investigate Modernair TA and TH Series Heavy Duty Cylinders. See your phone book yellow pages for your local Modernair distributor, or write us now for complete specifications, dimensions and prices.

Modernair ® Trademark **CORPORATION**

400 Preda Street • SAN LEANDRO, CALIFORNIA • Phone: LOckhaven 2-6485

5007 Brookpark Road • CLEVELAND 34, OHIO • Phone: SHadyside 9-6393

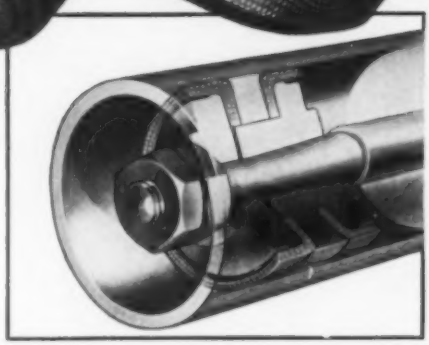
Copyright 1961
Modernair Corporation

MEMBER NATIONAL FLUID POWER ASSOCIATION

PUMPCUP ADVANTAGES now yours for

• HYDRAULIC CONTROLS
• AIR CYLINDERS
• RECIPROCATING PUMPS

Two common Pumcup types: conventional and 45° bevel type . . . available in a complete range of sizes and texture-engineered compositions.



Cutaway view of typical Pumcup installation resulting in prolonged high efficiency.

TAKE it from experienced users, Darcova Pumcups offer payoff advantages that can't be equalled! For example, they last many times as long as ordinary piston packing..and they *hold peak efficiency* from start to finish. Because of the resulting production and maintenance economies, plant after plant is standardizing on Pumcups.

Improved application of the cup principle does the trick. And Darcova Pumcups are *texture-engineered* in *a range of compositions* to meet most temperature-pressure-fluid conditions. And they are available in sizes and types exactly right for your particular equipment.

Pumcups are available in 100% Nylon as well as other texture-engineered compositions. Write for your copy of Bulletin No. 5903.

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP
TRADE MARK
PUMCUPS

Circle **35** on Reader Service Card

FORUM

will find it to our advantage to design most of the special hydraulic equipment ourselves.

W. A. ROMAN
Engineering Supervisor
American Machine & Foundry Co.
Greenwich, Conn.

We needed a special purpose valve that was to be used as a flow divider valve. It was not available in Japan, so we had to make it ourselves. It was for the power steering of shovel loaders and fork lift trucks.

T. YAMADA
Chief Engineer
Nippon Yusoki Co., Ltd.
Kyoto Fu, Japan

• What is the ideal pressure for your equipment? Could you benefit from higher pressure components? What kind of equipment do you design?

The selection of operating pressures for hydraulic circuits on our industrial type, material handling equipment is based on compromise of physical characteristics, cost of currently available hydraulic components, and service requirements of our equipment.

Our hydraulic circuits are designed for intermittent service and fluctuating loads, with peak loads seldom imposed. The average working load and hence operating pressure approximates 50% of the system capacity. With pricing being highly competitive, the use of the more sophisticated hydraulic components is precluded.

Space considerations are exceedingly important, particularly with reference to plumbing. The large diameter piping associated with low pressure systems is not only cumbersome and difficult to fit into the machine, but in many instances very costly. The price of fittings seems to increase much more rapidly with diameter than with design pressure.

The physical size and cost of hydraulic motors must be con-

Continued on page 24

In welded tubing the name to look for is "Ohio"

Beneath the four simple letters of the word "OHIO" on steel tubing lie four major reasons for always looking for this famous trademark:

Experience of over half a century practicing the tube maker's art . . . *Custom Quality* that always matches the tubing grade exactly to the application . . . *Service* that's second to none . . . *Unbiased advice* because we make both welded and seamless in parallel size ranges up to 7½" OD.

Let us "quote" on your next welded tubing job. We're fast and we want your business.

Representatives in principal cities. Check: THOMAS', MacRAE'S, FRASER'S, SWEET'S FILE.

A-3397A

See us at the
DESIGN ENGINEERING SHOW
Cobo Hall, Detroit - May 22-25

OHIO

OHIO SEAMLESS TUBE

Division of Copperweld Steel Company • **SHELBY, OHIO**

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

it's new
it seals
it saves

it's DELRIN*

Another RB&W development from Delrin plastic, this new threaded plug replaces more expensive metal plugs in many hydraulic and compressor applications.

It not only saves on cost and weight, but also does a better job. Fluid pressure forces mating threads together, creates a still tighter seal, locks threads in place.

Metal-like mechanical properties of Delrin provide excellent strength, dimensional stability, rigidity. Count also on resistance to corrosion and solvents.

Available in ⅛, ¼, ⅜, ½" pipe sizes. Send for samples.

Ask about other parts you would like custom-molded from Delrin, or other thermoplastics, in production quantities.

Write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

*Du Pont trademark

RB&W
116th year

Circle 110 on Reader Service Card

FORUM

sidered in conjunction with the associated speed reducer. A small, high speed motor coupled to a high ratio reducer in many instances, may be more bulky, costly, and less efficient and durable than a lower speed motor coupled to a reducer of a smaller reduction ratio.

These considerations have led us to the selection of gear or vane type pumps and motors with a peak design operating pressure of 2000 psi and with the motors operating at speeds of 750 to 1000 rpm. Noting that the system will be operating most of the time at pressures under 1200 psi, excellent service life of hydraulic components can be expected, particularly if ample filtration is provided.

It is our hope that future improvements in commercial hydraulic components will permit higher operating pressures, thus facilitating further reductions in plumbing size without sacrificing quality or increasing cost.

L. KAPLAN
Chief Engineer
Cullen-Friestedt Co.
Chicago, Illinois

Most of the design work that I engage in involves the use of remote handling and manipulation equipment. The most common pressure ranges are from 1000 psi to 1500 psi. Higher pressures would not be of that much greater benefit.

W. DOUGHERTY
Design Engineer
General Atomic Co.
San Diego, Calif.

The hydraulic and pneumatic equipment we use is in a test laboratory where our pressure range is anywhere from a near perfect vacuum to 6000 psi. Right now, 6000 psi is our limit because we are not equipped with the receivers, regulators, and valves necessary for working with higher pressure. We have higher pressure pumps and will soon have the rest of the equipment. We have requirements in the neighborhood of 10,000 to 15,000 psi, and expect to see higher requirements in the near future. Our equipment is both fixed and mobile, and is primarily used in support of missile and ground support equipment.

R. BELL
Manager
Testing Laboratory
Lockheed Missiles and Space Division
Sunnyvale, California

We do not manufacture a line of hydraulic equipment, but rather act as a consultant on specific applications. Consequently we have no ideal pressure.

But we are concerned that in designing a complete system, we are often unable to match all the components to a standard pressure rating. This is especially true in our attempts to employ high pressure servo controls.

D. W. BROOKS
Analyst
Armour Research Foundation
Chicago, Illinois

Our stationary radar and other GSE operate at 2000 to 3000 psi. The equipment is used for radar positioning and tracking, leveling, braking, jacking, etc.

Personally, I do not think much could be gained by having higher pressure components. Hoses are a problem at larger size and higher pressures. On press work, however, in which I spent 20 years, something could be gained by higher pressures. When using water, 4250 psi is usual. Consequently, the press is smaller for the same tonnage. It is the cylinder which determines the size of a forging press, not the die space required.

H. H. MILLER
Senior Design Engineer
Goodyear Aircraft Corp.
Akron, Ohio

Our business is making and testing pressure vessels and components. Customers' demands determine our requirements. We are working with pressures to 200,000 psi. This pressure will suffice until better materials are available.

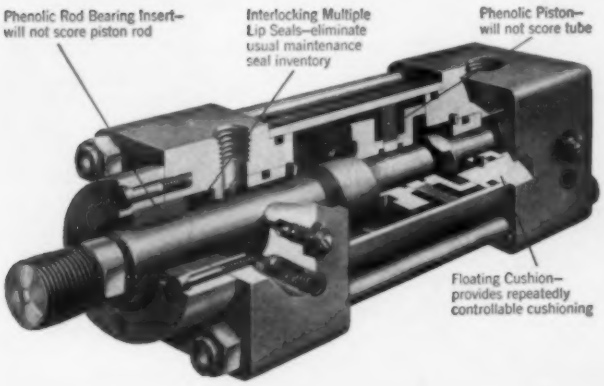
R. HOFER
Senior Project Engineer
National Forge Company
Irvine, Penna.

▼▼▼

Fluid Circuitry News from Westinghouse

Industrial Product Division expands line

The Petch line of high quality air and hydraulic cylinders is now part of the line of Westinghouse Fluid Circuitry components. This acquisition makes it possible for us to offer industry the *most complete line* of air and hydraulic components for control systems to automate industrial production operations.


Phenolic Rod Bearing Insert–will not score piston rod
Interlocking Multiple Lip Seals–eliminate usual maintenance seal inventory
Phenolic Piston–will not score tube
Floating Cushion–provides repeatedly controllable cushioning

The Petch line of rugged, precision made cylinders include the following models:

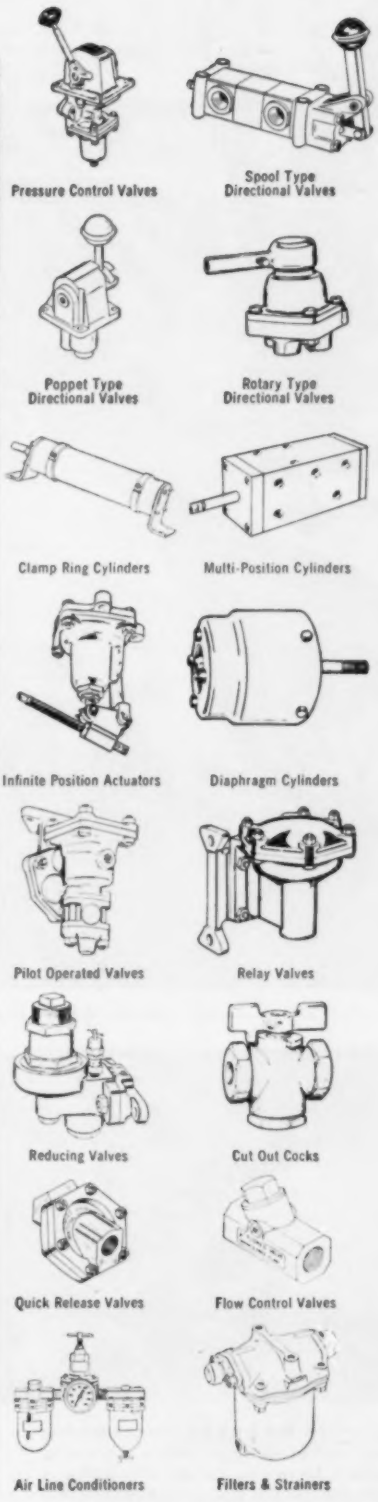
Air & Low Pressure Hydraulic Cylinders

150 psi Air 500 psi Hydraulic
1″ to 10″ Bores
10 Standard Mountings

High Pressure Hydraulic Cylinders

1½″ to 6″ bores—2000 psi
8″ to 10″ bores—3000 psi
10 Standard Mountings

All Petch Cylinders conform to J. I. C. Standards.



FLUID CIRCUITRY... FOR TROUBLE-FREE AUTOMATION

Fluid Circuitry is the application of fluid control systems to industrial production operations.

Fluid Circuits are economical, safe and precise. They are used to solve the most vigorous and complex control problems.

They contain reliable products to boost your production and cut your production costs.

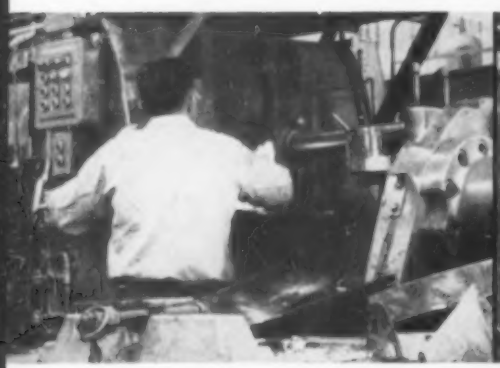
For more information on Petch Cylinders and Fluid Circuitry ask for catalog A3-56.00.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

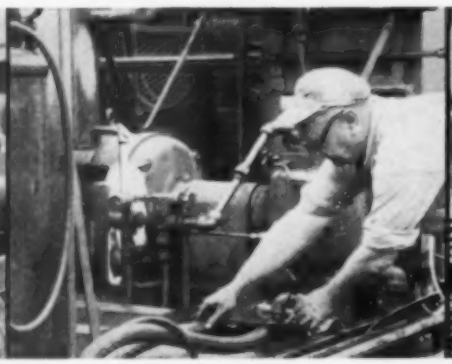
WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

PREVENTIVE MAINTENANCE with PYDRAUL®

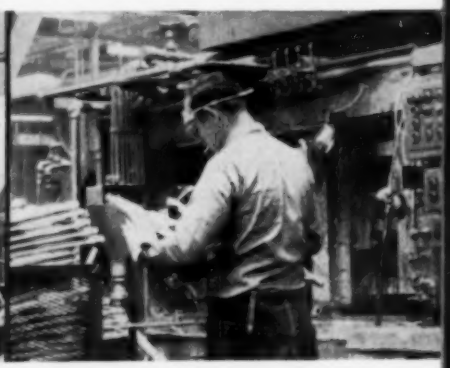
Electronic nerve center of Singer's mile-and-a-half-long conveyor system at Elizabethport, N. J.



PREVENT HAZARDS. Singer worker pours molten aluminum into a die-casting machine. There's no danger of flash fire or explosion even if a sudden hydraulic line break sprayed Pydraul fluid on hot metal or an open switch.



PREVENT HIGH UPKEEP. At Singer the hydraulic systems are filtered while the die-casting machines keep operating. The Pydraul fluid stays clear and clean. No corrosion. No drainage.



PREVENT DOWN-TIME. Singer's sixteen massive Lester-Phoenix die-casting machines must work around the clock to produce parts for 10,000 family sewing machines each week. Down-time can't be tolerated. Pydraul fluid helps prevent it.

The Singer Manufacturing Company speeds output, cuts upkeep time 75%

PROBLEM: 24-hour production, to meet demand for Singer's new Series 400 family sewing machines, made elimination of down-time *imperative.* Water-glycol hydraulic fluid in Singer's die-casting machines provided fire resistance... but the upkeep was formidable. Frequent pump and valve failure, rust, and sludge clogging were critical.

SOLUTION: Change-over to PYDRAUL A-200 fluid. Now, Singer's die-casting systems are filtered *while operating full blast.* Hydraulic systems stay clear and clean. No sludge, no rust, no wasted fluid.

RESULT: (1) greatly reduced down-time losses; (2) no valve replacements; (3) *total maintenance time cut 75%*... despite the fact that Singer now operates twice as many die-casting machines as before!

Says Al Schaefer, manager of Singer's Elizabethport, N. J., die-casting department: *"These operating economies are a direct result of our change to PYDRAUL A-200 fluid. In fact, the change not only solved rough maintenance problems but the permanence of PYDRAUL cut direct costs, too. This fluid doesn't evaporate. We don't have to drain it. And I think it gives us 100% better lubrication than the water-based fluid. No worry about fire, either."*

PYDRAUL fluids are straight synthetics—*chemically* compounded from fire-resistant materials; won't flash or flame after contact with hot ignition sources—*not even when sprayed through a 6,000° F. oxyacetylene torch flame* (AMS-3150B and MIL-F-7100 high-pressure ignition tests). PYDRAUL fluids contain no water to evaporate or corrode metal ... or throw your machine out of whack by rapid build-up in viscosity. Lubricity rivals the finest petroleum oils. PYDRAUL fluids perform well under line pressures up to 5,000 psi, at temperatures up to 300°F.

COMPARE VITAL PROPERTIES	PYDRAUL	Water-Glycol Fluid
Lubricity under heavy loads	Excellent	Fair
Oxidative stability	Excellent	Poor
Thermal stability	Excellent	Poor
Vapor pressure	Very low	High
Foaming resistance	Excellent	Fair
Oil compatibility	Excellent	Poor
FIRE RESISTANCE	Excellent	Excellent*

*provided water has not evaporated!

PYDRAUL fluids provide the *safety* you desire ... plus the *performance* you need. You owe it to yourself (and your workers) to get the complete facts on fire-resistant PYDRAUL fluids. Mail the handy coupon today.

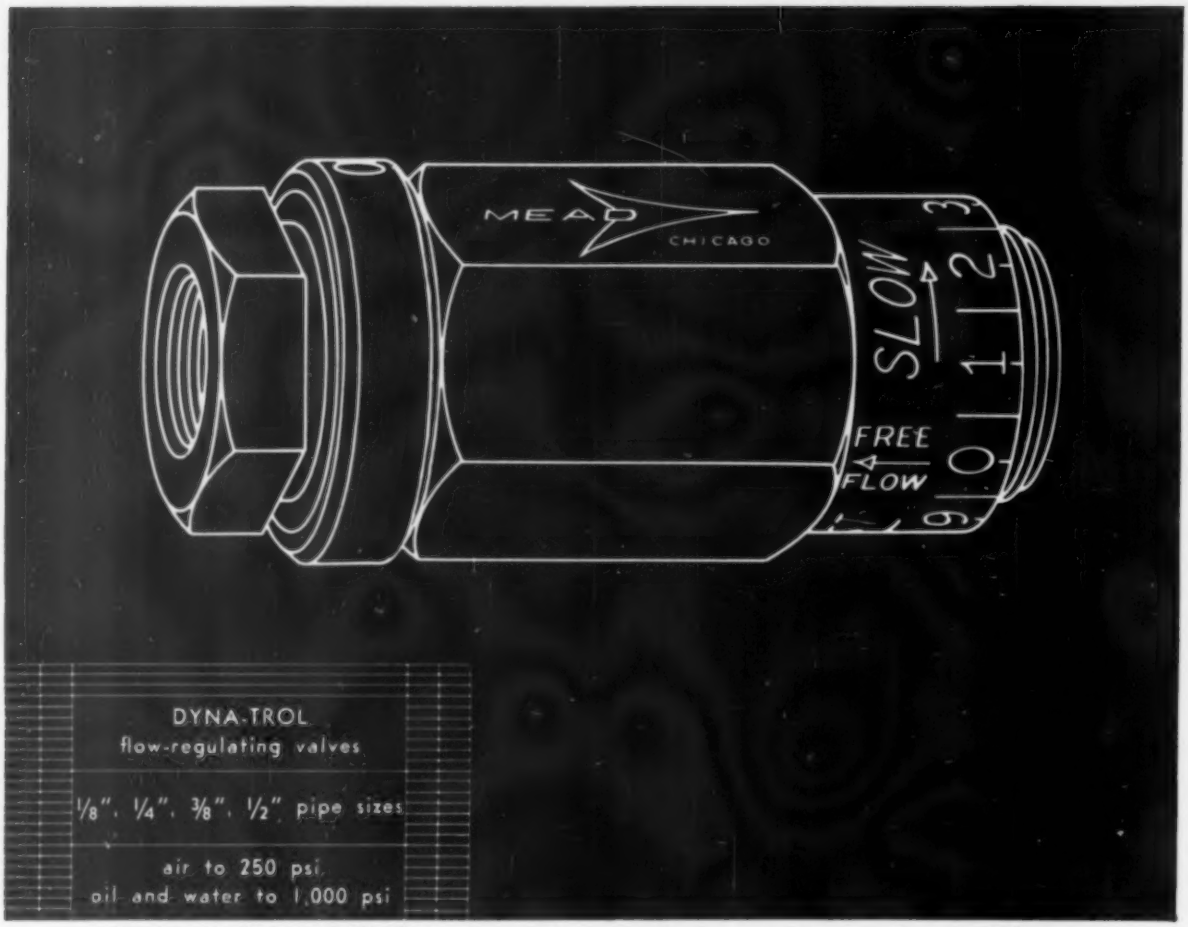
PYDRAUL SAFEGUARDS die-casting machines • hydraulic presses • furnace filters • mold casters • stampers • extrusion presses • ingot loaders • injection molding machines • forging presses. **Over 500 million machine hours' service proves PYDRAUL performance!**

Monsanto®

MONSANTO CHEMICAL COMPANY
Organic Chemicals Division
Industrial Fluids Dept. 4425-R
St. Louis 66, Missouri

Please send me these new bulletins:
☐ "Know Your Fire Hazards"
☐ "Preventive Maintenance in Fire-Resistant Hydraulics"

*Name*_____
*Company*_____
*Street*_____
*City*_____ *Zone*____ *State*_____



PROBLEM: how to replace a 1/4" valve with a less-costly 1/8" valve (and get extra precision in low-flow ranges)

SOLUTION: NEW MEAD DYNA-TROL VALVE

Check these design advantages of the new MEAD DYNA-TROL flow-regulating valve:

- Adjusting sleeve — easily rotated by hand — locks to any setting and cannot be accidentally removed from valve body
- Calibrated sleeve records settings for future reference
- Knife-edge variable orifice reduces flow distortion caused by viscosity changes in working medium
- No internal springs to cause malfunction
- All parts rust-proof
- Wide operating range: −40° F. to +250° F.

Small, economical MEAD DYNA-TROL flow-regulating valves can replace more costly valves of larger pipe size. Reason: Internal design permits pneumatic or hydraulic flow equal to full pipe area in both directions. The first 360° turn of the adjusting sleeve increases flow from zero to about 10% of potential — a new measure of precision in low-flow ranges. Successive turns accurately reach 100% of pipe capacity. To cut costs and give exacting control to piston speeds, specify MEAD DYNA-TROL valves to solve your flow regulating problems. For information on quick delivery, write to MEAD *today*.

PRODUCTS FOR AUTOMATION

MEAD
FLUID DYNAMICS

A DIVISION OF MEAD SPECIALTIES CO.
4114 N. KNOX AVE., Dept. 141, CHICAGO 41, ILL.

ASK YOUR MEAD MAN for more dollar-saving automation ideas

"All the world's Our stage"...

Manufacturers all over the world have discovered the importance of fitting SUPERFECT Oil Seals and Hydraulic Packings for perfect performance under the most exacting conditions.

There is a type of Seal to meet virtually every need. When a new project is in the course of development, our Research Department is available for the SUPERFECT solution to every sealing problem.

A brand new catalogue is in the course of preparation. May we reserve one for you?

SUPERFECT

SUPER OIL SEALS & GASKETS LTD.

KINGS NORTON FACTORY CENTRE, BIRMINGHAM 30, ENGLAND

Manufacturers of 'SuPerfect' Hydraulic Packings and 'O' Rings; 'Romet' water pump seals and mechanical pump seals; 'Fidrac' Mechanical rubber mouldings; 'Redcaps' Polythene Protective Caps and Plugs.

FLUID POWER AT WORK

keeping up with design, application, methods

Overcenter pump meters lock gate flow

• By OTTO F. KLIEVE, *Field Engineer, The Oilgear Company, Milwaukee, Wis.*

OPERATING GATES OF THE EISENHOWER LOCK are closed. The vertical liftgate proceeds the operating gate in the background (upstream) and is stored under water beneath the lock chamber.

EIGHTY gpm is returned to tank from a cylinder with a 44". bore x 24'-stroke. That is a total flow of 1830 gal. This flow must be controlled and coordinated with an equal flow from a duplicate cylinder and system. How should such a large return flow be controlled and coordinated?

• **Cylinders Raise Liftgate**— The 350-ton vertical liftgate is raised to stop water flow through the Eisenhower Lock of the St. Lawrence Seaway. Ordinarily, the gate is stored under water beneath the lock chamber. It is raised during maintenance and repair on the operating gates and during emergencies, when the operating gates are damaged, to prevent flooding of the areas downstream of the lock.

There is an identical hydraulic system and cylinder on each wall of the lock. The two cylinders raise and lower the liftgate with wire rope through a system of sheaves. Other hydraulic cylinders push dogging pins into the liftgate to hold it in its raised position, so that the sheaves can be lowered and the hydraulic system depressurized.

Continued on page 32

HUNT

Air and Hydraulic

CONTROL VALVES

Whatever the application . . . whatever the service . . . whatever the pressure range . . . whatever the size . . . whatever the actuation required . . . chances are you'll find a valve in the Hunt line *exactly* suited to your needs.

Sizes range from ⅛ through 8 in. for vacuum to 300 psi air and for water, soluble oil and water, or oil to 5000 psi.

Your nearby Hunt representative will be pleased to work with you. You'll find him listed in Sweet's Product Design File.

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

For more information, write for Bulletin 603. Address Dept. AH-461, Hunt Valve Company, Salem, Ohio.

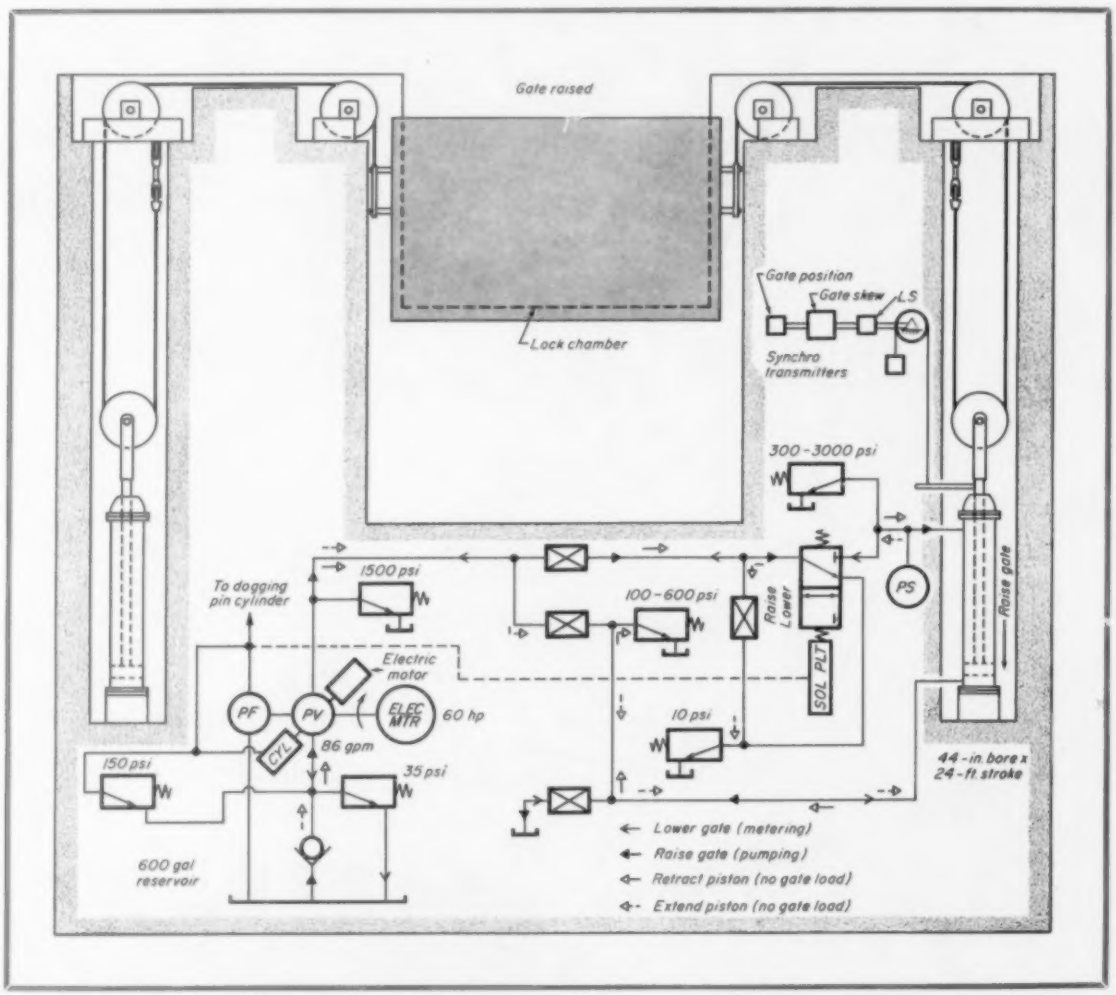
3001

• Synchro Coordinates Pumps—During gate raising, an automatic, skew correction system coordinates the flow from the two pumps. A synchro is the heart of the coordinating system. Even though pump flows are matched to ¼%, the correction system senses that one side of the gate is higher than the other and makes the correction by momentarily reducing flow from the higher-side pump. Specifications call for not more than six skew corrections while raising the 46-ft high x 83-ft wide gate. A correction automatically occurs when the gate is 1½" askew.

• Pump Meters Flow—To control the large return flow during gate lowering, it is desirable to use the same skew correction system as is used for raising the gate. To achieve this, the pump has to pump in either direction, and to meter oil out of the cylinder at the same rate as it pumps it in.

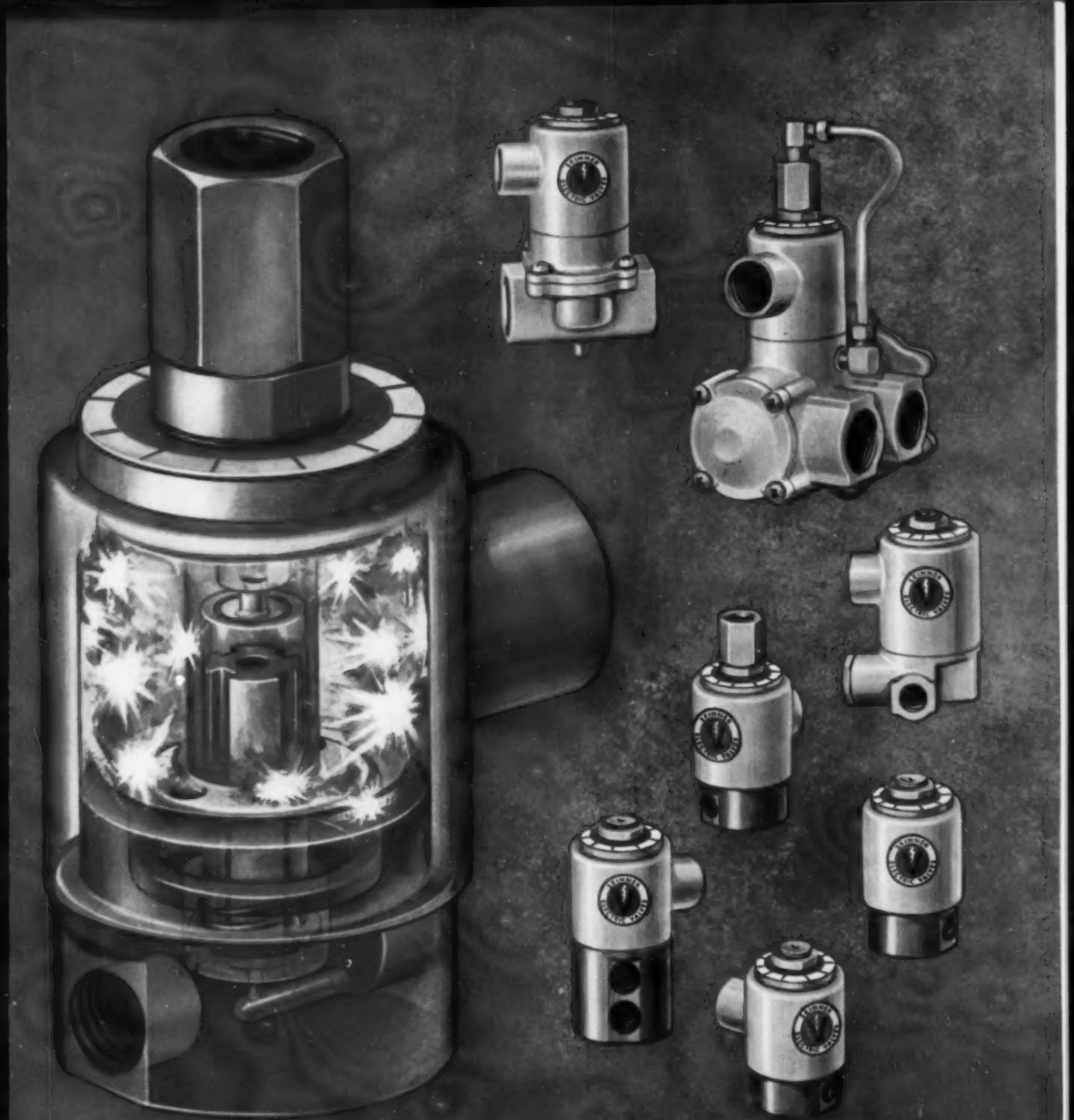
The direction of flow of an *overcenter* pump can be reversed. Its slide block can move to either side of neutral, thus delivery can be reversed during gate lowering. Although overcenter pumps can deliver pressurized flow in either direction, in this application the reversed flow need only be a metering or controlling flow, since the 350-ton gate lowers by gravity. During metering operation, the 2-way, variable delivery pump is driven as a hydraulic motor. The raised gate's potential energy is dissipated by the electric drive motor acting as a generator. This system provides accurate, synchronized lowering with a minimum of oil heating. So the automatic skew correction system is

Continued on page 36



TWO GIANT CYLINDERS move the 350-ton vertical liftgate to stop water flow through the lock. The cylinders have identical hydraulic systems. The two pump flows to raise and lower the gate evenly are synchronized by a synchro system. Flow to the cylinder for all piston movements is through the same position of the main, 3-way valve.

Circle 113 →

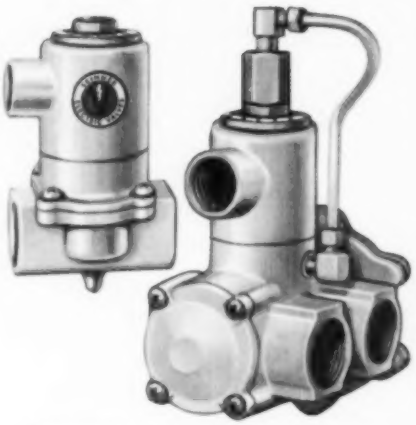


SKINNER EXPLOSION-PROOF SOLENOID VALVES

Skinner has a complete range of Explosion-Proof Solenoid Valves

If you have a control problem involving valves operating in hazardous locations—Class I Group D (gasoline vapors, etc.), Class II Group F (coal and coke dust) and Group G (grain dust)—you can select from Skinner's complete line of two- and three-way explosion-proof standard and high pressure solenoid valves.

- **U.L. approved**
- **A wide range of pressure ratings and orifice sizes**
- **Bodies and coil housings machined to close tolerances—clearance is 0.0005**
- **Stainless steel or naval brass bodies**
- **Stainless steel internal parts**
- **Stainless steel and brass internal parts**



STAINLESS STEEL TWO- AND THREE-WAY SOLENOID VALVES—X5 SERIES

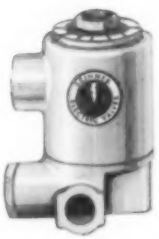
The highest quality and most versatile valves manufactured. So flexible that basic valve can be modified to provide porting, mounting, or flow-control, to meet most applications.

Two-way solenoid valves are available normally closed, normally open and dual purpose. Orifice sizes from 1/32" to 3/4", maximum operating pressure differential 3000 PSI depending on orifice size—NPT pipe size 1/8", 1/4" and 3/8".

Three-way available normally closed, normally open, directional control and multi-purpose. Orifice sizes from 3/64" to 1/4", maximum operating pressure differential 200 PSI depending on orifice size.

TWO-WAY PISTON TYPE SOLENOID VALVES—XR SERIES

These valves, with forged naval brass body and stainless steel piston, handle high flow and high pressure requirements of industrial and commercial applications with most common media.



XR series valves are available with 1/4" orifice and 1/4" NPTF in normally closed or normally open construction. Operating pressure differential 5 to 1250 PSI for AC operation and 5 to 1000 PSI for DC operation.

TWO- AND THREE-WAY HIGH FLOW SOLENOID VALVES—XL SERIES

These diaphragm type solenoid valves meet the high flow requirements of a great many commercial and industrial applications. The unique Skinner diaphragm construction makes possible the exceptionally long service life of this series valves.

Two-way XL series valves are available normally closed and normally open. Orifice sizes are 1/2", 3/4" and 1" with corresponding NPTF pipe connections. The 1/2" orifice model is also available with 3/8" NPTF. Operating pressure differential is 5 to 150 PSI.

Three-way XL series valves are available normally closed, normally open and directional control. Orifice sizes are 3/8", 1/2" and 3/4" with corresponding NPTF pipe connections. Operating pressure differential is 5 to 150 PSI for the 1/2" and 3/4" size and 10 to 150 PSI for the 3/8" size.

TWO- AND THREE-WAY HIGH PRESSURE HYDRAULIC SOLENOID VALVES—X10 SERIES

These stainless steel, direct acting, slide-type valves are precision engineered to control hydraulic systems at pressures up to 2000 PSI.

These high pressure hydraulic valves have a 3/32" inlet and cylinder orifices with 1/8" NPT. They can be used as two-way normally closed or two-way

normally open valves by plugging the appropriate port, and three-way normally closed, or three-way normally open, or dual purpose valves.

• • •

For complete information, contact a Skinner Distributor listed in the Yellow Pages or write us at the address below.

When you specify solenoid valves, specify Skinner. Skinner solenoid valves are distributed nationally.

THE CREST OF QUALITY

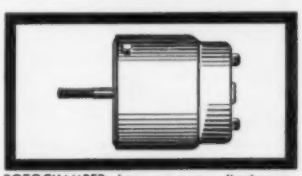
SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION
SKINNER PRECISION INDUSTRIES, INC. • NEW BRITAIN, CONNECTICUT, U.S.A.

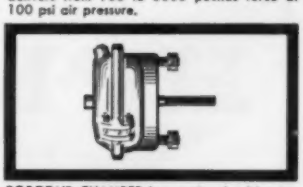
PRINTED IN U.S.A.

Quality materials and craftsmanship... Bendix-Westinghouse Power Cylinders

You can count on Bendix-Westinghouse for the best in design, materials, and manufacture. Our power cylinder capabilities result from actual experience in every imaginable application—medium, heavy-duty, standard, and special. Our comprehensive inventory of machined parts for standard units, combined with our manufacturing flexibility, means fast delivery to meet your needs. In addition to the broad range of standard models, we can "customize" to your requirements with specialized sizes and mounts. Write today for complete information on the quality advantages you enjoy with Bendix-Westinghouse engineering and manufacturing.



ROTOCHAMBER has neoprene diaphragm, delivers from 900 to 5000 pounds force at 100 psi air pressure.



ROBOTAIR CHAMBER has optional rubber or neoprene diaphragm, delivers from 300 to 3600 pounds force at 100 psi air pressure.

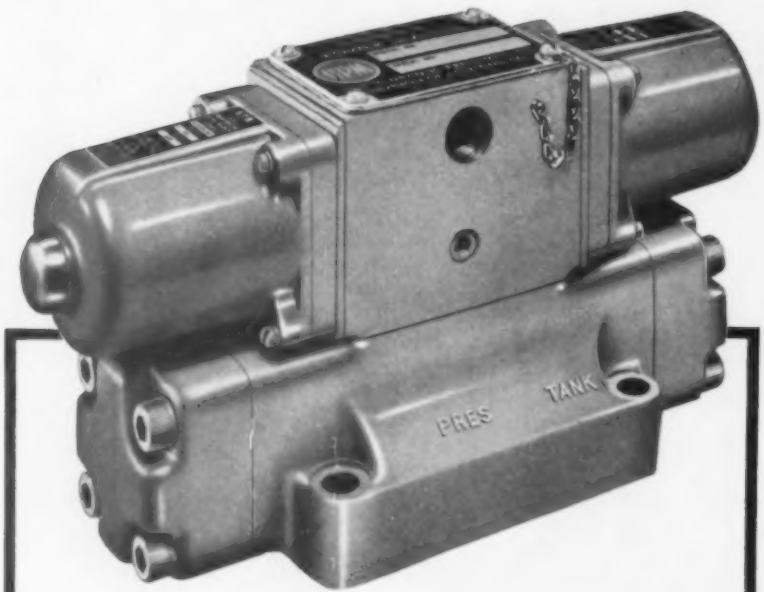
Bendix-Westinghouse BW

INDUSTRIAL PRODUCTS

Bendix-Westinghouse Automotive Air Brake Company, Elyria, Ohio

INTERCHANGEABLE

H-P-M ¾" and 1¼" 4-way valves



These solenoid operated, pilot controlled 4-way valves are designed for continuous, heavy duty 3000 psi service. They feature oil immersed solenoids as standard to lessen shock and wear on both solenoids and valve parts. They are completely interchangeable with industry standards and are available for fast delivery from stock.

These H-P-M 4-way valves offer unusually good flow characteristics. Pressure drop charts, the result of actual tests, are available. They illustrate the high efficiency of the H-P-M design. Send for your copy today. Dimensional specifications will be included.

H-P-M DIVISION
Koehring Company
Mt. Gilead, Ohio, U.S.A.

HPM

H127

Circle **48** on Reader Service Card

used during both gate-raising and lowering. The synchro control system directs a 3-hp, geared head, control motor which moves the pump slide block through a work nut and screw, to vary volume and direction of flow.

• **Load Removed From Piston**—In addition to raising and lowering the liftgate, the hydraulic circuit is designed to raise and lower the piston and sheaves when there is no gate load, that is, when the gate is secured with dogging pins in the raised position. This is necessary for doing maintenance work on the wire rope and sheave system. With no gate load the pump does not meter. It pumps for both piston extension and retraction. So flow to the cylinder is reversed by opening or closing globe valves which direct flow to either the head or rod end. The globe valves are also used periodically for preventive maintenance. The valves block off flow from the pump, thus loading it, to test its volumetric efficiency and sound without operating the gate.

You can win up to $500 by entering the
1961 FLUID POWER PRIZE PAPER CONTEST
For details circle 220 on reader service card

The suction check valve on the pump permits free flow from the tank to the pump during pumping. But during metering, the check forces return flow to tank through a relief valve set at 35 psi, to provide back pressure on the pump.

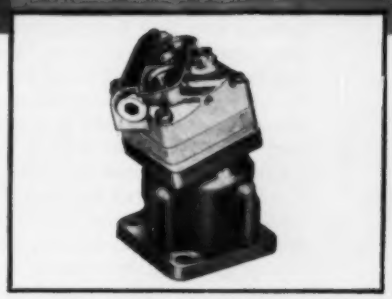
A small, 150-psi auxiliary gear pump is integral with the main pump. The gear pump supplies fluid to actuate the dogging-pin cylinder, pilot pressure to the main, 3-way valve, and supplies fluid to the auxiliary control cylinder of the main pump slide block. This cylinder holds the slide block firmly against the opposing slide block control screw. ▼▼▼

Continued on page 40

Circle **69** →

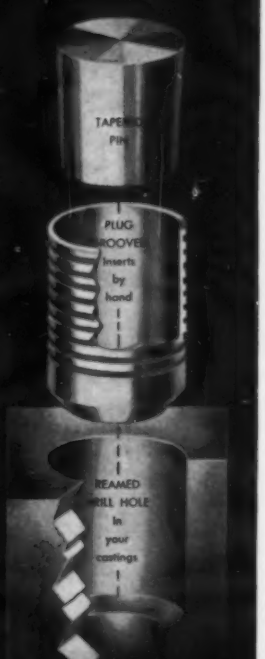
SEALED FOR DELIVERY

Lightweight, reliable Vickers valves with extremely low internal leakages.



New fixed angle, integrated Vickers variable delivery motorpump offers high efficiency combined with important weight savings.

Main hydraulic supply for missile control system specially insulated for high ambient temperatures.



LEE PLUGS provide reliable drilled hole seals for the new VICKERS valves and variable delivery pumps used on the NAVY'S NEW NUCLEAR SUBMARINES AND THE POLARIS MISSILES LAUNCHED FROM THEM!

LEE PLUGS are being used by Vickers Incorporated in the production of vastly improved, integrated, efficient, shockproof, lightweight valve and hydraulic pump systems that are now playing a vital part in the U.S. defense network of nuclear submarines, missiles, and ordnance.

LEE PLUGS provide bone dry seals in the intricate new housings designed to withstand pressures up to 9000 PSI (burst). Reliable LEE PLUGS install simply, quickly without specialized equipment, save time and money. Investigate the ways LEE PLUGS can help your product.

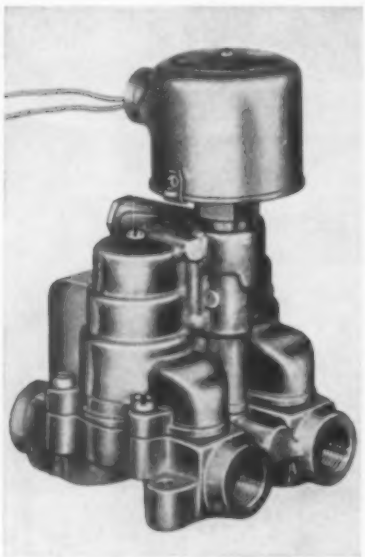
Write today for complete engineering data

LEE COMPANY

OLD SAYBROOK, CONNECTICUT

Why Name an Air Valve "Mach 2"?

"Mach 2" is the name of a new Crescent® Air Valve now ready for distribution to industry. An identifying name is desirable for this valve to point up the new kind of performance it brings to air control and to distinguish it from the other valves in the long-established Crescent® line.



The new Crescent "Mach 2" 4-Way Valve. (Half-inch pipe size shown.)

A Breakthrough in Cycling Speed

Actually these Crescent® "Mach 2" 3-Way and 4-Way Air Valves represent a breakthrough, as the name suggests. For years a cycling speed of 600 to 700 cycles a minute seemed to be the limit for solenoid pilot valves. The original Crescent 4-Way Valves attained that speed a long time before other valves even approached it. Now, the "Mach 2" has been tested and rated for 1000 cycles per minute continuous duty. During a two-hour test at a speed of over 1500 cycles per minute the coil temperature stabilized at 7°C below the maximum code limit for class A coils. Cycling speeds as high as 2100 have been successfully reached for intermittent periods of 20 minutes.

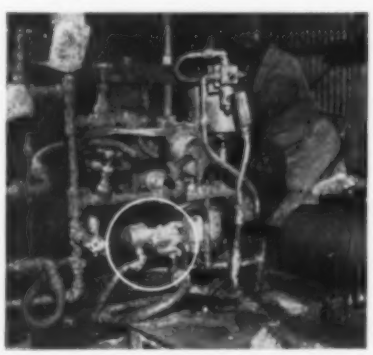
Brings New Dependability

We realize that such high cycling speeds are seldom needed. However, speed and endurance seem to be Siamese twins. Here's why: (1) Speed depends on an extremely short stroke of the solenoid plunger (3/32 of an inch—approximately the thickness of a nickel—in the new "Mach 2"). This greatly reduces coil heating and, as heat goes down, coil life expectancy goes up. (2) High cycling speeds demand a drastic reduction of friction in the solenoid and pilot valve section. In the "Mach 2" pilot valve, a tiny ball seats on "O" rings at both ends of a pilot cartridge. The ball moves freely, independent of the seals. There is no "O" ring drag on the pilot plunger because it requires no seals; where there is no friction there can be no wear.

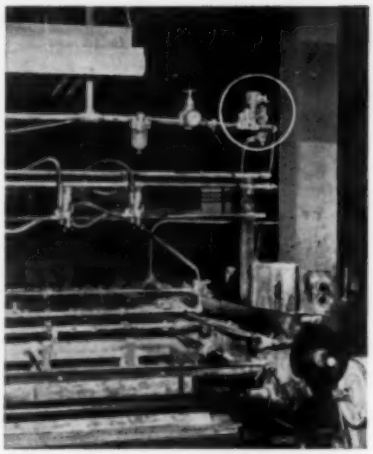
Similarly, the main valve seats seal on "O" rings. Metal shoulders take the shock in such a way that the "O" ring seal is merely kissed by the seat in the sealed position; since they are only minutely flexed they don't fatigue or lose their resilience.

100 Million Cycle Guarantee

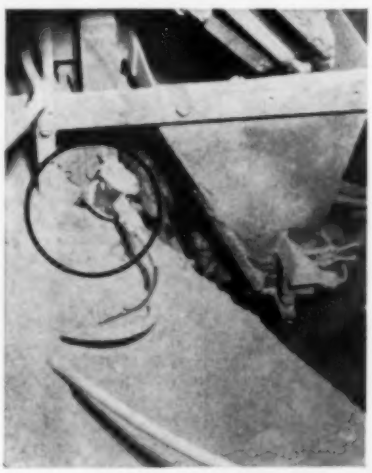
Because of the short solenoid plunger stroke and the elimination of friction, there seems to be no limit to the endurance of the solenoid coils in "Mach 2" Valves. We back up this statement by guaranteeing the coil life for a minimum of 100 million cycles. For six years "Mach 2" Valves have undergone test. Valves have been placed in some of the toughest applications we could find to test their performance capabilities in actual service before introducing them to the market. Some were installed in plants where they were subjected to very fast-cycling, continuous operation. Others have been operating where they are exposed to excessive dirt, dust and dampness, and in all cases the "Mach 2" Valves are performing flawlessly. In fact, some operators balked at having us remove them for inspection. To test the new waterproofing treatment of the "Mach 2" coils, one of the units was completely submerged in a container of water on April 26, 1959, and it is still functioning perfectly.



Crescent "Mach 2" 4-Way Valve on a roofing paper machine. This machine operates 24 hours per day, 7 days per week.



Large printing press used to imprint cardboard cartons. "Mach 2" 3-Way Valve controls spray nozzles which apply "offset spray." Production speed of this machine is 2000 cycles per hour.



This Crescent "Mach 2" 4-Way Valve operates the hopper doors at a cement batching plant. The valve has been operating at 1400 cycles per day surrounded by dry cement. We actually had to dig the cement away from the valve to get a picture.

Write for the "Mach 2" Catalog

Crescent® "Mach 2" Solenoid Pilot Operated Air Valves represent a significant breakthrough in "the cycling speed barrier" and in valve life and operating dependability. We hope you will approve of the unusual name, "Mach 2." We know you will approve of the low-cost, downtime-free performance the "Mach 2" will deliver on your tough jobs. Please write to Barksdale Valves, 5125 Alcoa Avenue, Los Angeles 58, California, and request an advance copy of the "Mach 2" catalog.

Circle 17 on Reader Service Card

Circle 15 →

PROBLEM

To LOCK, hydraulically a slave unit at any point in its stroke

We have been meeting these requirements for many years by the use of the Hydroloc unit, easily introduced into any hydraulic system. This unit automatically locks the piston at any point in its stroke, resisting reactive forces and vibration until pressure is applied to move the ram to the new position.

One or two units are used, according to whether locking is needed in one or both directions.

Two models available—up to 2 g.p.m. and up to 20 g.p.m. Working pressures up to 3,000 p.s.i.

Two of the many hydraulic units made by Lockheed, all of which are protected by the company's goodwill and many by British and foreign patents.

Full particulars on application from:

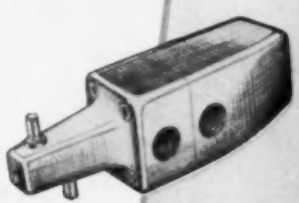
LOCKHEED PRECISION PRODUCTS LIMITED

INDUSTRIAL HYDRAULICS DIVISION

SHAW ROAD, SPEKE, LIVERPOOL 24, ENGLAND

Telephone: Hunts Cross 2121 *Telex 62394*

Telegrams: Lockheed, Liverpool, Telex



At the Engineering, Marine, Welding & Nuclear Energy Exhibition, Olympia, London, April 20th to May 4th. Stand No. 4, Grand Hall

Lockheed

REGD TRADE MARK

INDUSTRIAL HYDRAULICS

ONE OF THE AUTOMOTIVE PRODUCTS GROUP

RACINE
hydraulic components
THE heart OF BETTER MACHINERY
Here are but a few of the many OEM'S and end users of RACINE EQUIPMENT that rely on its day-in, day-out dependability and performance superiority. You, too, can get the same sort of money-saving reliability from the equipment you use or produce by installing stout-hearted RACINE HYDRAULIC COMPONENTS.

American Motors Corporation
Armstrong Cork Company
"Bendix Products Division — The Bendix Corporation"
E. W. Bliss Company
Boeing Airplane Company
Briggs & Stratton Corporation
Buhr Machine Tool Company
J. I. Case Company
Caterpillar Tractor Company
Celotex Corporation
Chrysler Corporation
Danly Machine Specialties, Inc.
Eastman Kodak Company
Emerson Electric Manufacturing Company
Firestone Tire & Rubber Company
Flintkote Company
Gleason Works
B. F. Goodrich Company
Goodyear Tire & Rubber Company
The Heald Machine Company
Geo. A. Hormel & Company
International Harvester Company
Jones and Lamson Machine Co.
F. Jos. Lamb Co.
Lockheed Aircraft Company
Minneapolis-Honeywell Regulator Company
Monsanto Chemical Company
Pullman Incorporated
Radio Corporation of America
Radio Corporation of America (Whirlpool Corporation Division)
Republic Aviation Corporation
Republic Steel Corporation
Revere Copper and Brass Incorporated
Reynolds Metals Company
R. J. Reynolds Tobacco Company (Archer Aluminum Division)
Singer Manufacturing Company
A. O. Smith Corporation
Snyder Corporation
Stewart Warner Corporation
The Timken Roller Bearing Company
Trane Company
Union Carbide Corporation
United States Steel Corporation
Wilson & Company, Incorporated

Racine Hydraulics & Machinery, Inc.
RACINE, WISCONSIN
HYDRAULICS DIVISION

RACINE

Circle **99** on Reader Service Card

FLUID POWER AT WORK

Book Review

La Commande Hydraulique, *by C. R. Himmler, 424 pp, published by Dunod, Paris, France*

In this new book (in French) on hydraulics, the author, who is Director of the Hydraulic and Electrical Research Center in France emphasizes the important relation between hydraulics and electrical controls, and discusses thoroughly the subject of electro-hydraulics. After an introduction of the basic concepts and principles of hydraulic theory, he discusses various types and designs of major hydraulic components: pumps, motors, valves, filters, cylinders, tubes, hoses, and fittings. There are comprehensive sections on hydraulic applications in marine equipment, presses, machine tools, automobiles, aircraft, and mobile equipment.

The book covers in detail the use of electrohydraulic controls, servo mechanisms, regulating valves, and amplifiers. It lists and illustrates the use of JIC symbols. Profusely illustrated with graphs, drawings, switches, tables, circuits, and photographs.

FPS News

Growth and expansion of the Fluid Power Society has proceeded at a more rapid pace than optimistically anticipated. The Society recently passed another milestone, when its national membership surged past the 600 mark. National headquarters are confident that at this rate, the goal of 1000 members by July 1 will be easily topped.

President Mackin made a swing-visit trip through the United States and Canada, and reported on the progress of many chapters. The interest displayed in many parts of the country has been keen. Many areas have already organized into active chapters of the Society and have received membership charters.

● **Michiana**—Late in January, President Mackin attended an organizational meeting of this Chapter, at South Bend, Ind., and presented its charter. Members are from as far away as St. Joseph and Kalamazoo. A slate of temporary officers was elected, headed by Forrest House, Bendix Products Div., as chairman. It was decided that these officers will remain in office for the balance of the current administrative year. This chapter will hold monthly meetings for the rest of the season.

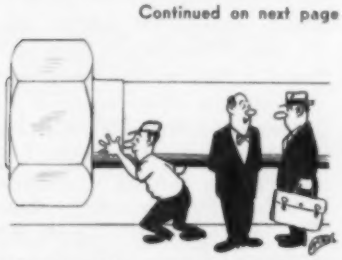
● **Cleveland**—Formally organized in October of 1960, this Chapter's meetings have been very well attended. Meetings are scheduled every other month, and every effort is made to diversify program topics in order to draw the varied interests of all members. The February meeting, which drew close to 90 members and guests had Don Arnold of Denison Engineer-

Rexford *Arnold*

ing, and Ken Rexford of Hydraulic Press Manufacturing Co., discuss hydraulic and electrical design for sequencing fluid power systems. The March meeting dealt with leakage control.

● **Rockford**—Designation as Chapter No. 6 went to Rockford which held its organizational meeting in January. Temporary officers were elected. Election of officers will be held later for the year

Continued on next page



"Just a section of the hydraulic piping for our new long range transport".

TRANSFER MACHINE BUILT BY BUHR MACHINE TOOL CO., ANN ARBOR, MICHIGAN

Automated GIANTS like this

REQUIRE STRONG HYDRAULIC *HEARTS* EVERY MINUTE OF THEIR WORKING LIFE

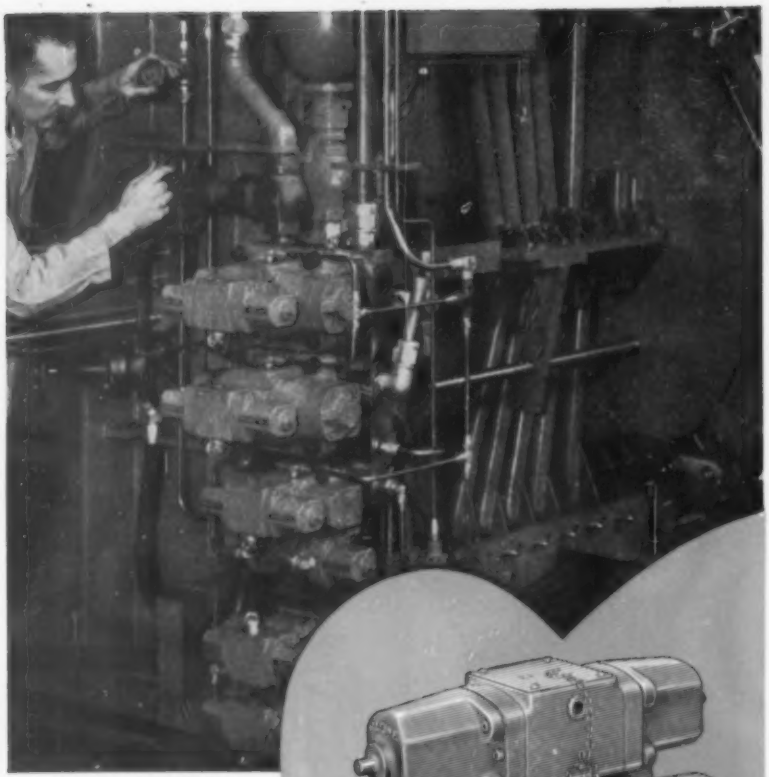
24 RACINE PUMPS *operate this 58 station 500-ton transfer machine*

The precisioned flow control of RACINE PUMPS assures the split-second timing and efficiency required to operate this complex Buhr Transfer Machine . . . custom-built for the completely automatic machining of 120 auto-cylinder heads hourly for a leading automotive manufacturer. Compact RACINE VALVES control feeds and reverse movements on all 323 operations performed by the machine. RACINE 4-WAY SOLENOIDS help one man operate this mechanical giant. Buhr has used RACINE PUMPS and Reservoir Units on custom-built machines for the automotive industry for over 10 years.

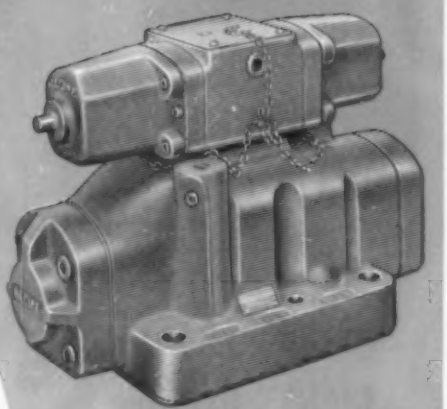
RACINE

Racine Hydraulics & Machinery, Inc.
RACINE, WISCONSIN
HYDRAULICS DIVISION

Circle **100** on Reader Service Card



HYDRAULIC VALVE SYSTEM OF WIRE-FORMING MACHINE BUILT BY RESEARCH DESIGNING SERVICE, INC., CENTERLINE, MICHIGAN



during set-up and at 3000 springs per hour

RELIABLE VALVES DIRECT THE POWER OF A HYDRAULIC HEART

"Control of all our hydraulic operations is vital, and this is possible with RACINE equipment," says Bill Karolle, electrical engineer with Research Designing Service, Inc. "Our hydraulic machines are used to form wire for 80% of all automobile seat springs." As oil requirements change constantly during set-up operations, 6 RACINE DIRECTIONAL CONTROL VALVES guide the *right oil volume* at the *right pressure* to the *right place* at the *right time*. At high production speeds, these 4-way, solenoid-controlled valves maintain the pre-set wire forming pattern with absolutely uniform precision. Valve reliability is important since these machines may perform over five million cycles during their lifetime.

6 RACINE

Directional Control Valves guide hydraulic wire-forming operations of this machine

RACINE

Racine Hydraulics & Machinery, Inc.

RACINE, WISCONSIN

HYDRAULICS DIVISION

Circle **101** on Reader Service Card

FLUID POWER AT WORK

starting July 1. Temporary officers are: Bruce Lundgren, Sundstrand Corp., chairman; George Finn, Ingersoll Milling Machine Co., secretary; Jack EauClaire, J. M. Grimsted, program chairman; and Ken Shane, Norman Engineering Co., membership chairman. The chapter plans to meet on the second Tuesday of each month.

• **Minneapolis-St. Paul**—This chapter held its organizational meeting in January. Geo. E. Carlson, of Minnesota Rubber Co. and Robert L. Firth, of Char-Lynn Co., served as temporary president and secretary, respectively. Lynn Charlson, president of Char-Lynn, and a member of the Society's Board of Directors outlined the background and aims of the Society. Membership decided to meet monthly, and discussed the types of programs and activities the chapter should schedule.

• **Boston**—The Boston Chapter held its first meeting in January and immediately proceeded to organize on a formal basis. Officers were elected, with Jules Kendall, Kennett Corp., as president. He was largely responsible for getting the group together. The Chapter will meet on the second Tuesday of each month at Hotel 128, Dedham, Mass.

• **Houston**—A meeting to organize a Houston Chapter was held in February at the Houston Engineering & Scientific Society's headquarters. Frank H. Smith, president of Hydraquip Corp., under whose leadership the chapter is being formed, presided.

• **Detroit**—Approximately 85 people attended the chapter January meeting in Warren, Mich., and heard a panel of four instructors in hydraulics (from schools in the Detroit area) discuss *Fluid Power Education at the High School Level*. It was considered by many in attendance to be a most constructive meeting. The Chapter met again in February for a program on air controls.

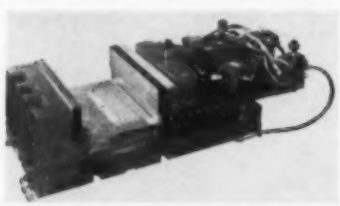
• **Milwaukee**—Undaunted by "circumstances beyond his control", versatile program chairman Harold Johnson, overcame adversity with a very fine program. Substituting for a scheduled plant visit, Charles Conklin, field representative of E. I. duPont Company, gave a very interesting talk on properties of Teflon and its application in fluid power. The postponed plant tour through Galland-Henning Mfg. Co. is being rescheduled.

• **Rhode Island**—A group that will draw heavily from Providence and Pawtucket held an organizational meeting of the local chapter last March. Efforts to organize this group are spearheaded by Milton M. Dubin, Lincoln Supply Co.

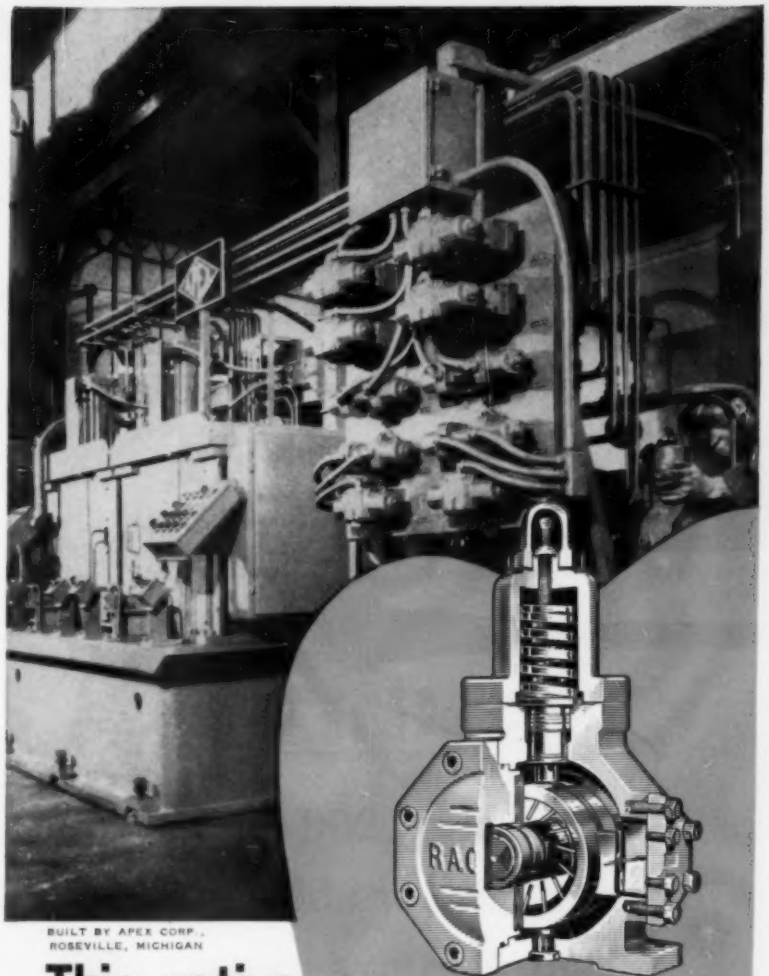
• **Toronto**—Over fifty people attended the first meeting of the Toronto Chapter when President Mackin presented the members its Charter, making it officially Chapter No. 10. Much of organizational work was done by A. Douglas Kaill, Editor of Design Engineering. Interest in the chapter is shown by its attendance: one man travelled from Montreal (350 miles) while three came from Kitchner (60 miles) to attend the meeting.

• **Toledo**—Twenty persons attended the organizational meeting of the Toledo Chapter last January, and heard George Altland, president of the Detroit Chapter, and a Director of the Society, explain the aims and purposes of this new organization. The following officers were elected for the

Continued on page 47



ONE CONTROL HANDLE actuates this low pressure, hydraulic vise, which is driven off the mill's own hydraulic system. Normal operating pressure is 300 psi. Hydraulic control valve is remotely located, for operator convenience and safety. Vise can be adapted to any vertical mill of adequate horsepower. Manufactured by Acme Precision Products, Inc., Dayton, Ohio.



BUILT BY APEX CORP., ROSEVILLE, MICHIGAN

This active hydraulic heart helps

the HEART of this impregnating machine is a RACINE MODEL 6FA PUMP

SEAL POROSITY IN 106 TRANSMISSION CASES EVERY HOUR

A RACINE VARIABLE VOLUME PUMP and 10 RACINE VALVES control *all* mechanical operations in this Apex impregnating machine, which seals leaky transmission cases at a major auto firm's transmission plant in Toledo, Ohio. Apex specified RACINE equipment because its design simplifies machine design problems . . . eliminates the need for extra pumps and valves. RACINE PUMPS are easy-to-control . . . handle pressure compensation *automatically* for varying gpm requirements. Apex has *preferred* RACINE for over 10 years!

RACINE

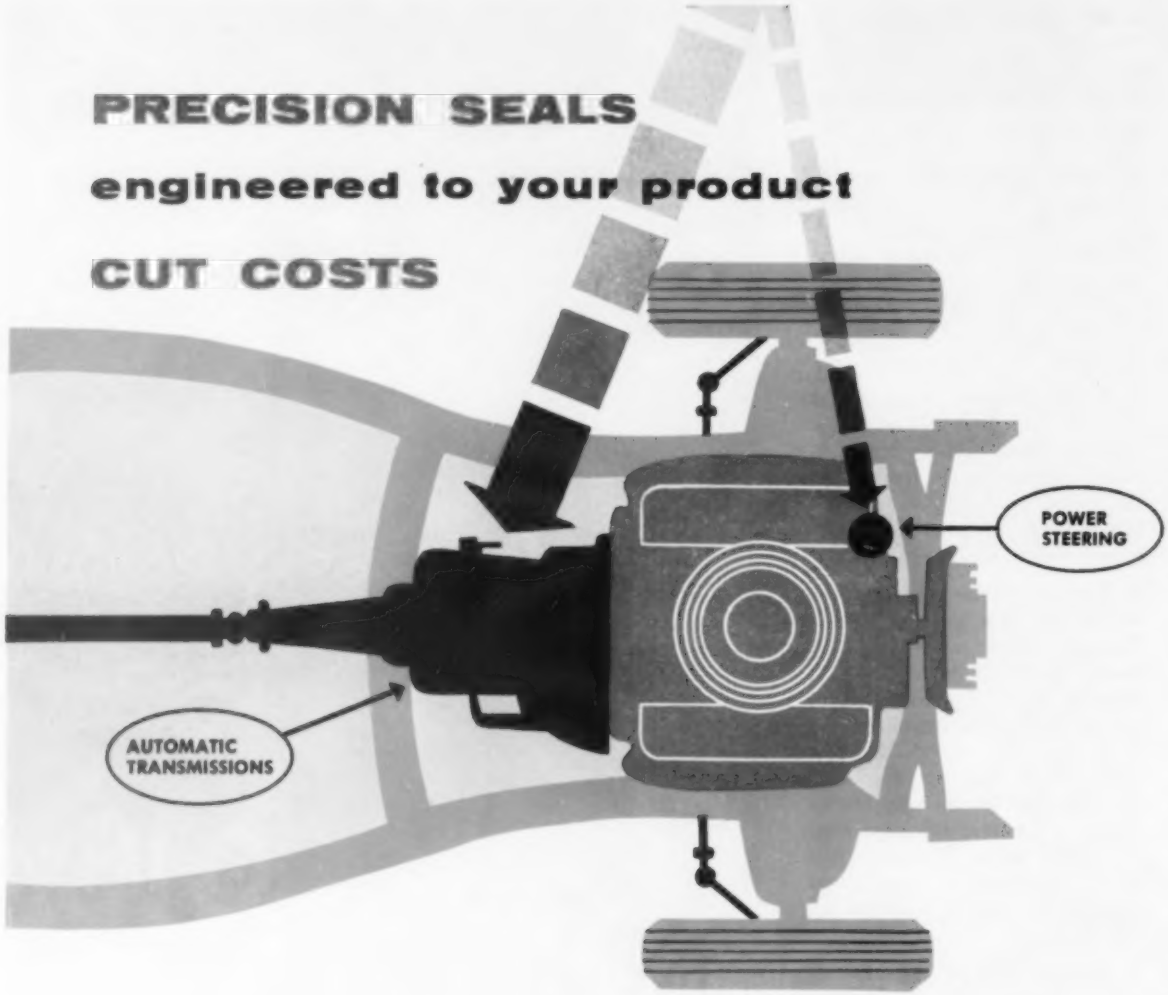
Racine Hydraulics & Machinery, Inc.
RACINE, WISCONSIN
HYDRAULICS DIVISION

Circle **102** on Reader Service Card

PRECISION SEALS

engineered to your product

CUT COSTS



Problem Solving is a common occurrence at Precision. One was the development of a universal compound for automatic transmissions and power steering systems. **The Solution** Precision Compound No. 6767—provided an "O" Ring with these characteristics. Suitable for all transmission fluids . . . particularly type "A" . . . long life over a temperature range of —40F to 300F . . . excellent resistance to cracking . . . low volume change . . . low compression set . . . high modulus. Precision creative research has reduced costs by producing the right "O" Ring for many manufacturers. You can benefit too, for the services of a Precision engineer are available to help you obtain the right product design and the right "O" Ring for it. Write or phone for his services today.

Precision Rubber Products Corporation

"O" Ring and Dyna-seal Specialists

Dept. 1, Oakridge Drive, Dayton 17, Ohio **Canadian plant at: Ste. Thérèse de Blainville, Québec**

Circle **98** on Reader Service Card

Circle **112** →

Irus 902 is bright yellow—helps you spot leaks quickly.

BULLETIN:

Shell reveals how Irus 902, the bright yellow hydraulic fluid, holds water in oil to reduce fire danger in your plant

Shell forced Irus® 902 Hydraulic Fluid through a 0.145-inch orifice at 1000 psi pressure. A 3000-degree flame was thrust into the streaming fluid. Irus 902 did not ignite.

Read the remarkable story of Irus 902—why it resists fire—and how it can help you protect personnel, plant and equipment.

IRUS 902 Hydraulic Fluid is an ingenious combination of oil and water. The water is encased in a film of oil. In technical terms, it is a stable water-in-oil emulsion.

But unlike other emulsions, Irus 902 has optimum stability. This is vitally important. It means that Irus Fluid will retain its lubricating qualities far longer than most fire-resistant oils—and will not allow the water to separate out.

Result: the water stays in the oil, ready to snuff a fire if needed.

Other Advantages

1. *Irus 902 cools off systems.* Because of its high rate of heat transfer and high heat capacity, Irus 902 allows hydraulic systems to run cooler.

2. *Irus 902 resists thickening and thinning.* Viscosity of Irus 902 protects pump parts during the entire working cycle—from cold start-up to hot, continuous operation.

3. *Irus 902 saves gaskets, packing, hose.* It's gentle to nonmetallic parts as well as metal.

4. *Irus 902 resists foaming.* It does not hold captive air. If air enters, Irus 902 quickly releases it.

For complete details about changing over to Shell Irus 902, contact your nearest Shell Industrial Products Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, N.Y.

A special message to manufacturers of hydraulic equipment

Shell Irus 902 makes an excellent initial fill. It is available anywhere in the U.S.A. Its quality is consistently high. All Irus 902 must meet Shell's strict quality control specifications.

SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are working to provide better products for industry.

DOES YOUR OIL SEAL VENDOR ACCEPT QUALITY CONTROL AS *HIS* RESPONSIBILITY?

To insure performance from their products, manufacturers constantly look for means of assurance that their purchased components are manufactured to high standards. In many cases this requires costly inspection, sorting or testing.

If you conduct such tests on Oil Seals, for example . . . How well equipped must you be? What size sample should you take? How proficient must your inspection be?

We can tell you – *in fact we can show you* . . . for IPC has pioneered the most complete, exhausting QC procedures that exist anywhere in the Oil Seal industry. Modern equipment operated by highly skilled technicians control every phase of IPC's production.

That explains increasing demand for IPC products. It also explains why our customers have fewer inspection headaches.

Why not get your next Oil Seal problem to IPC? You can rely on our "custom" approach to your problem and we will be happy to show you the elaborate QC steps that will insure the results *you* want.

IPC

OIL SEALS
PACKINGS
PRECISION MOLDING *Custom designed for your application*

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

© IPC

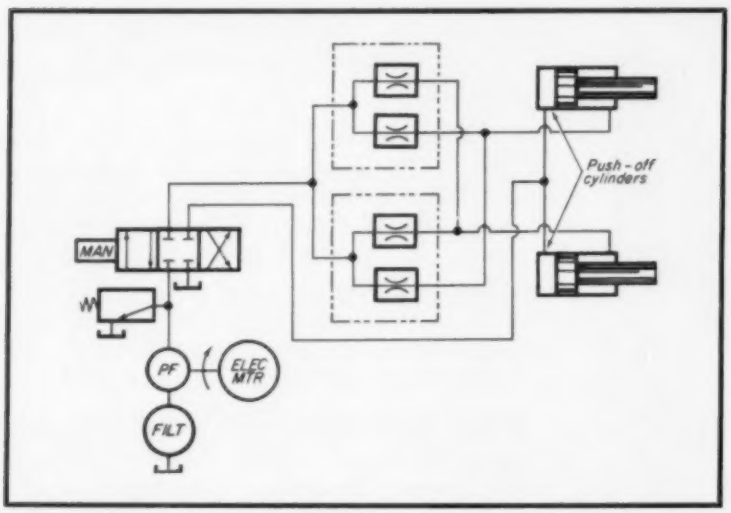
FLUID POWER AT WORK

coming year: president, Harold A. Yarnell, Surface Combustion Div.; vice president, Alva E. LaChance, S. G. Morris; secretary, Jean Tremblay, Champion Spark Plug Co.; treasurer, Ted C. Sheets, J. N. Fauver Co.; membership chairman, Robert J. Burns, F. & W. Ursem Co.; program chairman, Wm. Hullhorst, Owens-Corning-Fiberglass; publicity chairman, Kenneth Ritchie, Williams & Co.

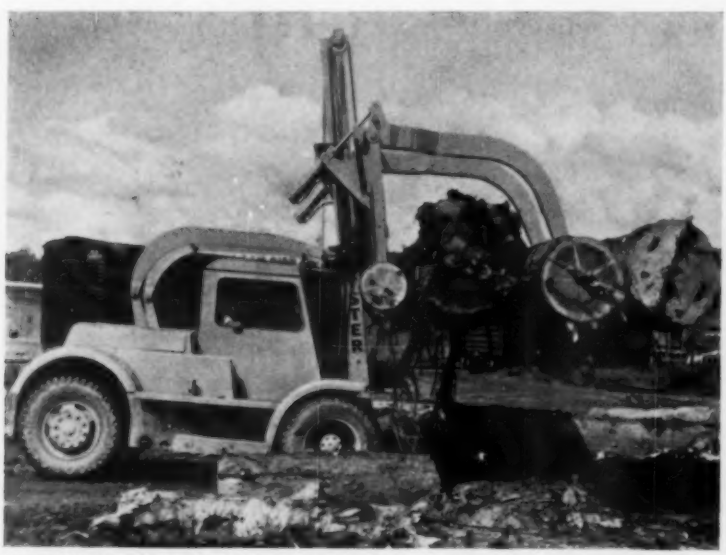
Flow dividers equalize cylinder speeds

This hydraulic clamp and log-kicker designed and manufactured by Hyster Company, Portland, Oregon, has two push-off members that roll large logs off heavy-duty, log-loading arms. Two arc-shaped clamp-arms can reach 144 in. and

Continued on page 51



FLOW DIVIDERS divide pump output into equal flows which are used to actuate two cylinders whose pistons move in parallel.



LOG KICKER-CLAMP for 15,000-20,000 lb capacity lift trucks.

New, compact
PRESSURE CONTROL VALVE

for low-pressure or high-pressure circuits

The Dynex pilot-operated, hydraulically balanced pressure control valve is designed for simplified application and low-cost installation. Functions efficiently at high or low pressures. Withstands severe shock loads. This new design features excellent characteristics of low override, low override with increasing volume, and quick reseating.

The same basic configuration adapts for service as a relief, sequence or unloading valve. Suitable for pressures to 8,000 psi and for flows to 30 gpm, with a liberal safety factor. To determine which design fits your current project, check the chart below. Write Dynex for data and application assistance.

Select the configuration that suits your needs

Typical Model Number ▶ VR-6120-12-00

FUNCTION
R-relief
S-sequence
U-unloading

MAX. PRESSURE
1 - 1,000 psi
3 - 3,000 psi
6 - 6,000 psi

BODY DESIGN
1 - standard

GPM
10 20 30

DESIGN NO.

DRAIN
1 - internal
2 - external

ADJUSTMENT TYPE
1 - concealed
2 - exposed
3 - knurled knob

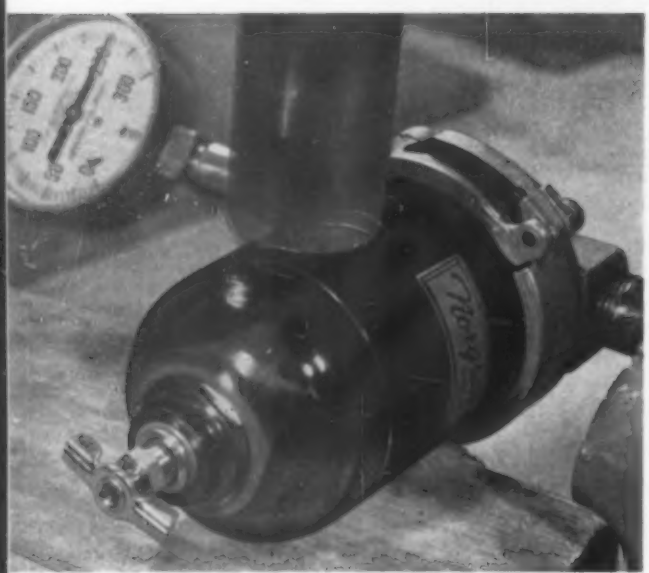
DYNEX INC.
THE LEADER IN HIGH-PRESSURE HYDRAULICS
FOR INDUSTRIAL AND MOBILE APPLICATIONS
777 DYNEX DRIVE • PEWAUKEE, WISCONSIN
Phone: Pewaukee 691-0300
HYDRAULIC PUMPS · VALVES · MOTORS · CYLINDERS · CIRCUITS

Circle **37** on Reader Service Card

NEW NORGREN SAFETY GREEN* TRANSPARENT BOWL WITHSTANDS RIPPING IMPACT OF BULLETS

*TRADEMARK

Norgren SAFETY GREEN* bowl doesn't shatter... yet is fully transparent



Heavy steel bar dropped endwise from 12 ft. height merely scuffed surface of bowl carrying over 200 psi internal pressure.

Bowls for compressed-air-line filters and lubricators should be transparent to permit quick visual inspection. However, in the past, unusual or special applications often required the use of bowl guards or wire reinforcements . . . sacrificing the advantage of transparency.

Now . . . from Norgren . . . you get a fully transparent, yet super-tough, impact-resistant bowl designed for even the most severe service. As these photos dramatically portray, the new Norgren bowls are transparent and are able to withstand conditions far more exacting than ever encountered in ordinary use. Non-shattering bowls mean reduced replacement cost, less air-tool and equipment down-time, savings in maintenance and operating costs, greater employee safety.

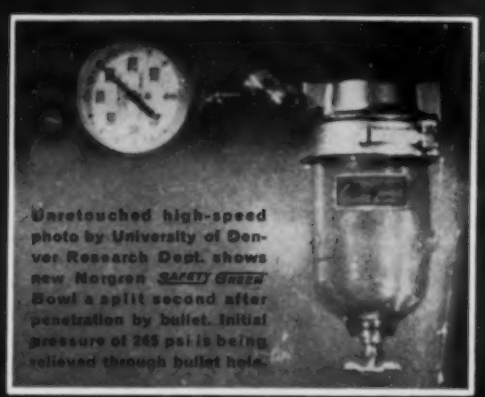
These new SAFETY GREEN bowls are now available for most Norgren air-line filters and lubricators—or may be obtained separately for replacement purposes from your local Norgren representative or distributor. Or, write for full information.

As a further test of toughness, the new Norgren bowl was placed in a heavy machine shop vise . . .

then compressed almost flat. Even in this extreme position, the bowl did not break or even crack.

Turned and squeezed again back to its original shape, the bowl still showed no cracking. Except for vise marks almost good as new!

...WITH NO SHATTERING!



Unretouched high-speed photo by University of Denver Research Dept. shows new Norgren SAFETY GREEN Bowl a split second after penetration by bullet. Initial pressure of 245 psi is being relieved through bullet hole.

Specify Norgren SAFETY GREEN Bowls

Large photo shows bowl after test. Only damage to bowl is clean bullet hole with no cracking, crazing or shattering. Impact has broken gauge. This test clearly demonstrates extreme toughness of Norgren SAFETY GREEN bowls.

FOUNDED IN 1926

. . . for complete information, write

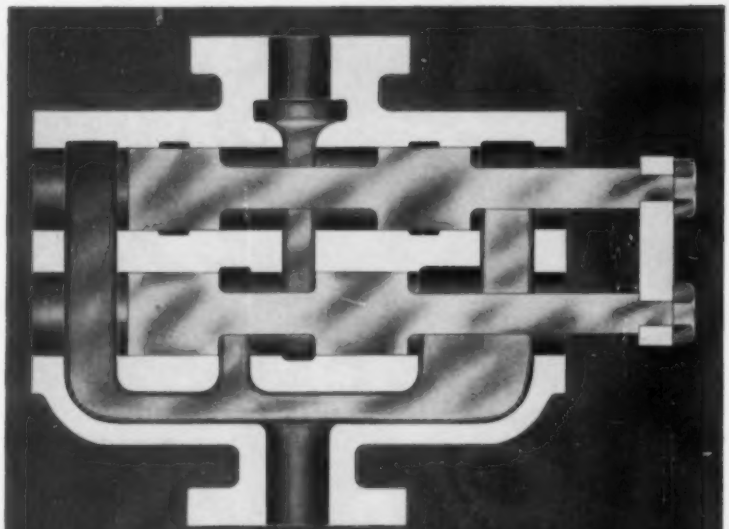
C. A. NORGREN CO.

3402 SOUTH ELATI STREET ENGLEWOOD, COLORADO

In Valves, it's the size inside that you're buying!

Four-Way Open Center Valve

- **LASSMAN VALVE has long spool stroke as a result of long lap for low clearance or leakage flow. COMPETITIVE VALVES generally have short spool stroke with short lap.**
- **LASSMAN VALVE has large porting for negligible power loss and low friction flow. COMPETITIVE VALVES have narrow slots and drilled holes resulting in high friction flow.**
- **LASSMAN VALVE has full pipe area in all positions through valve. COMPETITIVE VALVES have full pipe area at ports only, as low as *58% pipe area* with "Pressure" and "Cylinder" ports connected and as low as *35% pipe area* with "Pressure" and "Tank" ports connected (mid or center position).**



Standard LASSMAN 1½" 4-way open center valve

Standard COMPETITIVE 1½" 4-way open center valve

The flow area through any style of Lassman valve is never less than that of the equivalent Extra Heavy or Schedule 80 pipe. This means that the *nominal size* selected for your flow requirements is the *actual size* in a Lassman valve. It also means that there is no unexpected high back pressure with consequent power loss or malfunctioning of the system.

This is not true of all makes of hydraulic valves, and the illustration shows a typical case in point, a four-way open center valve, *with both valves drawn one fourth actual size.*

Of course, Lassman valves are priced according to the inside flow area, which means that they are priced higher than a competitive valve of the same nominal size. But as we say, "In valves it's the size inside that you're buying."

Lassman Valves are not cataloged

DIRECTIONAL VALVES

CHECK VALVES

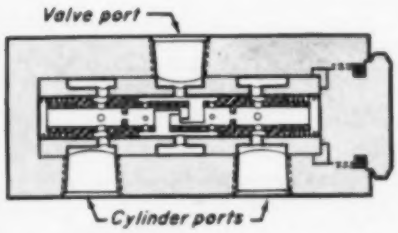
"ON-OFF" VALVES

SURGE (PREFILL) VALVES

SPECIAL VALVES

BENJAMIN LASSMAN & SON Route 8, GLENSHAW, PA.

swing 105 degrees to hold the timbers on the loading arms, until the logs are unloaded.



CROSS SECTION of flow divider used to split oil flow to cylinders.

Courtesy Fluid Controls, Inc.

When the clamp-arms begin to open, the push-off arms at first remain stationary. As the clamp arms continue their opening swing, the push-off arms engage automa-

Continued on next page

BRIEF NOTES

HYDRAULIC SHEAR TO RECLAIM SPENT URANIUM . . . Birdsboro Corp., will build a horizontal stroke type shear operated by a 100-gpm hydraulic power unit to cut-up and reclaim spent nuclear fuel elements. The shear represents the first processing step in reclaiming spent uranium.

LITERATURE ON SILICONE RUBBERS . . . Stillman Rubber Co., Culver City, Calif., announces it has new technical information available on fuel and oil resistant silicone polymers for seals and gaskets.

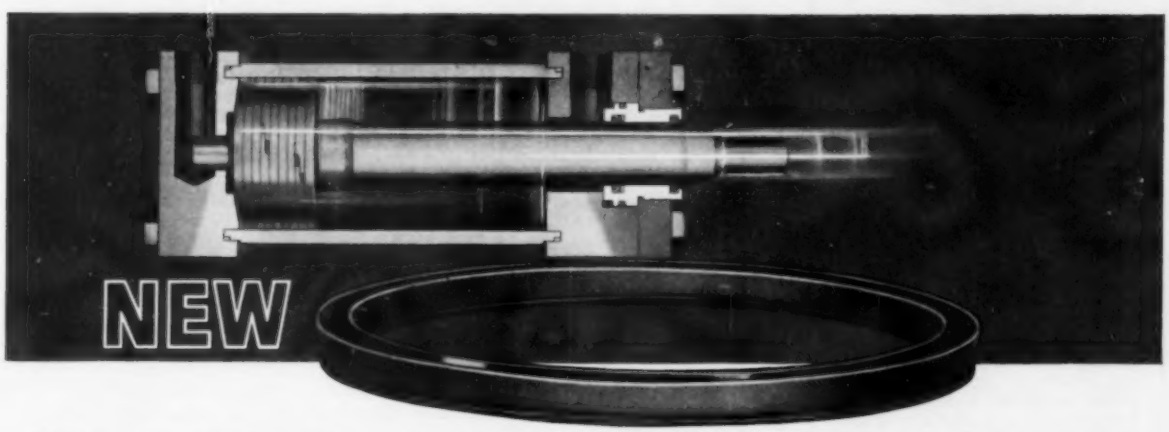
EXECUTIVE STRESSES TEAM WORK . . . "Everyone in your plant, from the switchboard operator to the last man on the night shift is a salesman for your product", Frank Flick, president of Flick-Reedy Corp. told a gathering of the sales Promotion Executive Association. Flick Reedy is the 1960 winner of the Silver Anvil Award of the American Public Relations Association of America. The company was also named one of the "Ten Plants of 1960" for demonstrating planning and ingenuity.

NEW UNIT TO TEST VISCOSITY . . . The Cincinnati Division of Bendix Corp., has developed a new viscosity measurement and control system for use in petroleum, medical, and polymer re earch and control laboratories.

EXPANDS R&D AND SALES PERSONNEL . . . Tri-Point Plastics, Inc., New York, has opened a new R&D center for Teflon products and application engineering. A larger sales representation and customer service operation has also been inaugurated.

HYDRAULIC SHOCK ABSORBERS FOR RR CARS . . . Hydraulic cylinders for railroad cars that operate on a principle similar to shock absorbing landing gears, have been developed by Bendix Corp., Products Div. The new cylinders are expected to reduce cargo damage and save the railroads millions of dollars in claims.

DURATON ROD SEAL IN HYDRO-LINE CYLINDERS



Here is a new opportunity to reduce machine downtime and costs caused by cylinder leakage or scoring: Hydro-Line's "Duraton" rod seal — exclusive durability formed from Viton®, guarded by backup washer of carbon-impregnated Teflon.

Leakproof seal is assured by superior resistance of "Duraton" rod seal-backup washer combination to abrasives, corrosives, and pressure. Retains effective resiliency at temperatures to 400°F and higher. Compatible with virtually all hydraulic fluids. Resists aging.

Iron-oxide-colored "Duraton" rod seals, Ebalon backup washers, and Viton wipers are standard on Hydro-Line Series N2 hydraulic cylinders to 5000 psi. See your Hydro-Line representative for details.

HYDRO-LINE

® Registered trademark of E. I. DuPont De Nemours & Company, Inc.

5601 PIKE ROAD, ROCKFORD, ILLINOIS, manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • boosters • adjustable-stroke cylinders • dispensing cylinders • single-acting cylinders • rod end couplers

Circle **59** on Reader Service Card

Young

BUILDS THE BEST HEAT EXCHANGERS

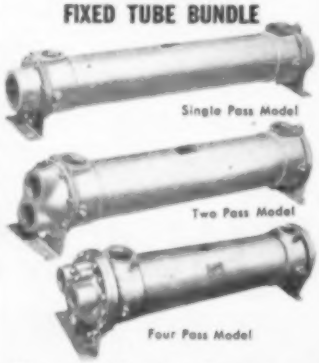
AIR COOLED OIL COOLERS

Type "OH" Unit

Cooling oil and space heating, when desired, are dual advantages of Young "OH" units. Available in ten sizes. Catalog No. 3560.

LIQUID COOLED HEAT EXCHANGERS

FIXED TUBE BUNDLE



Single Pass Model

Two Pass Model

Four Pass Model

Type "F" heat exchangers are made in copper base alloy, steel or stainless steel construction. Over 400 standard models. Catalog 1261.

REMOVABLE BUNDLE

Young type "R" heat exchangers are made in standard sizes. Quality-built for dependable performance. Low cost. Catalog No. 1160.

Young heat exchangers are used on all types of hydraulic equipment and in chemical, pharmaceutical and food processing equipment—can be furnished to ASME specifications.

Write Dept. D-441 for catalog required

YOUNG RADIATOR COMPANY
RACINE, WISCONSIN
Plants at Racine, Wis. and Mattoon, Ill.

Circle **129** on Reader Service Card

FLUID POWER AT WORK

tically, and push the logs off the forks. The same hydraulic cylinders operate both sets of arms in their proper sequence. Two flow dividers, operating in parallel, equalize clamp arm cylinder travel. The cylinders synchronize the movement of both push-off arms, and the logs are rolled off the loading arms with equal force at both ends.

The hydraulic clamp and log-kicker operates from the truck's 1800-psi hydraulic system. The attachment is for trucks of 15,000 through 20,000-lb capacities, and is actuated by a single hydraulic control lever. ▼▼▼

BUSINESS BRIEFS

ROSS TO OPERATE IN EUROPE . . . A sales and distributing network to cover the majority of Europe was announced by the Ross Operating Valve Co. Center of activity will be Ross Europa, of Frankfurt/Main. The facility will function as the central European factory representative and as marketing manager for representatives in a dozen other nations.

AMERICAN ENGINEERING MOVES . . . Materials handling systems and hydraulic systems of the American Engineering Co., formerly of Philadelphia, will be engineered and manufactured by AE Industrial Div. of Aircraft Armaments in Cockeysville, Md.

KEELAVITE TO SELL HIGH PRESSURE HYDRAULIC EQUIPMENT . . . Keelavite Hydraulics Ltd., Allesley, Coventry, England, have acquired world selling rights for a complete line of high pressure hydraulic equipment. The Keelavite/Gury line will include fixed capacity piston pumps and complementary control valves. Maximum system pressure will be to 7100 psi.

SPRAGUE TO MANUFACTURE, SELL IN ITALY . . . Sprague Engineering Corp., Gardina, Calif., and Aeronautica Macchi, Milan, Italy, have come to terms on the manufacture and sale of Sprague aircraft and missile support equipment in Europe, the Middle East, and North Africa.

AEROQUIP EARNINGS RISE IN 1960 . . . The Aeroquip Corp., Jackson, Mich., reports net earnings for the 1960 fiscal year of $2,768,893 compared to $2,711,280 in 1959. Earnings per common share rose from $2.18 in 1959 to $2.23 in 1960.

MERGER REVEALED . . . Atlas Copco Eastern, Paramus, N. J. and Atlas Copco Pacific, San Carlos, Calif. have merged and formed a new organization to be known as Atlas Copco, Inc. The merger became effective January 1, 1961.

FLUOROCARBON SHOWS PROFIT, EXPANDS . . . During its last fiscal quarter, Fluorocarbon Co., Annaheim, Calif., has expanded its R & D facilities and tripled its research personnel. For the same period sales increased 20%.

PUROLATOR BUYS WEST COAST PLANT . . . Purolator Products, Inc. has established a new West Coast plant at Van Nuys, Calif. The addition has facilities to design and manufacture all related aviation and missile type filters.

AMERICAN SEALANTS EXPANDS . . . The American Sealants Co. announces it has opened a new plant with sales and administrative offices in Newington, Conn., a suburb of Hartford.

MERGER AGREEMENT ANNOUNCED . . . Eastern Industries Inc., Hamden, Conn., and Laboratory for Electronics, Inc., Boston, have agreed to merge. Laboratory for Electronics makes airborne navigation systems, ground control radars, and other electronic devices. Eastern manufactures traffic controls, cooling systems and hydraulic products.

FUTURE EVENTS

NFPA SPRING MEETING

May 14-17

The Greenbrier
White Sulphur Springs, W. Va.

FLUID CONTROLS INSTITUTE MEETING

May 21-23

Sea Island
Georgia

ASME DESIGN ENGINEERING CONFERENCE & SHOW

May 22-25

Cobo Hall
Detroit

ASTME ENGINEERING CONFERENCE & TOOL EXPOSITION

May 22-26

New York Coliseum

HYDRAULIC FLUIDS SEMINAR

May 23

Allen-Bradley Hall of Science
Milwaukee School of Engineering
for registration information, contact
M. E. Striegel, Director, MSOE
Evening Div.

ASME SUMMER ANNUAL MEETING

June 11-15

Statler Hilton Hotel
Los Angeles

WESTERN PLANT MAINTENANCE SHOW

July 18-20

Pan Pacific Auditorium
Los Angeles

1961 CRYOGENIC ENGINEERING CONFERENCE

August 15-17

Univ. of Michigan
Ann Arbor

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS

October 19-20

Sherman Hotel
Chicago

NFPA FALL MEETING

October 24-26

Sheraton Hotel
Philadelphia

New Hydraulic Packing Designs..... Specification & Application Data....

Here is complete information on the finest available line of hydraulic packings . . . an extremely wide variety of types and constructions, each correctly compounded to particular service requirements and laboratory controlled to insure uniform quality. Available now from "John Crane", this complete line is the answer to practically every hydraulic packing requirement.

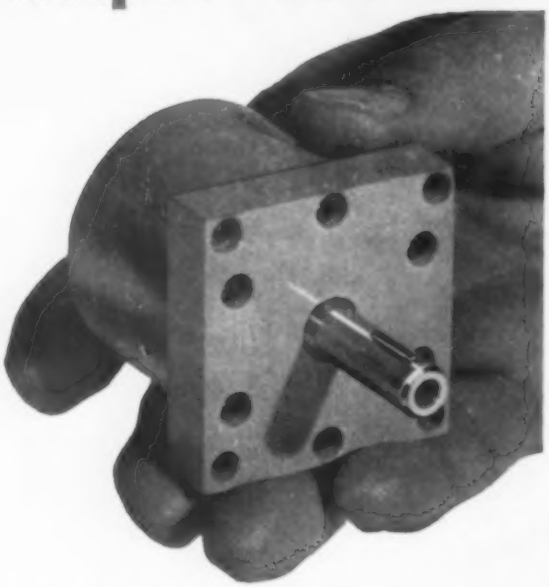
Request Catalog 90. You can't afford to be without this detailed engineering guide.

Crane Packing Co., 6405 Oakton Street, Morton Grove, Illinois *(Chicago Suburb). In Canada: Crane Packing Company, Ltd., Hamilton, Ont.*

CRANE PACKING COMPANY

Circle 33 on Reader Service Card

New Rotac MIDGET Rotary Torque Actuator



Use it to lift, lower, turn, rotate, index, clamp, transfer, toggle, press, load, unload, oscillate or turnover.

Mount it vertically, horizontally, or at any angle.

Rotate or oscillate it in any arc to 270° with either keyed shaft or body rotating.

Power it with air, oil or fire-resistant fluids.

Control it with simple valving for starting, stopping, slowing-down or speeding-up.

Apply it wherever you need instant torque and controlled rotary power. Current uses include: instrument and computer designs, small parts handling, remote control of valves and switches, and other light applications.

Count on it to measure-up to your needs. New Midget Rotac is only 2" x 2" x 2", weighs just 12 ounces (single vane model), with torque ratings up to 80 inch-pounds at 300 psi input (double vane model).

Examine its design by sending today for free design data book—gives engineering data, power ratings, mounting details. Or call your Rotac Representative for details.

EX-CELL-O
FOR PRECISION

XLO

EX-CELL-O CORPORATION 61-4RO

Greenville Plant, 945 E. Sater Street • Greenville, Ohio

PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • JIG AND FIXTURE COMPONENTS • TORQUE ACTUATORS • CONTOUR PROJECTORS GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

Circle **40** on Reader Service Card

Money Isn't Everything

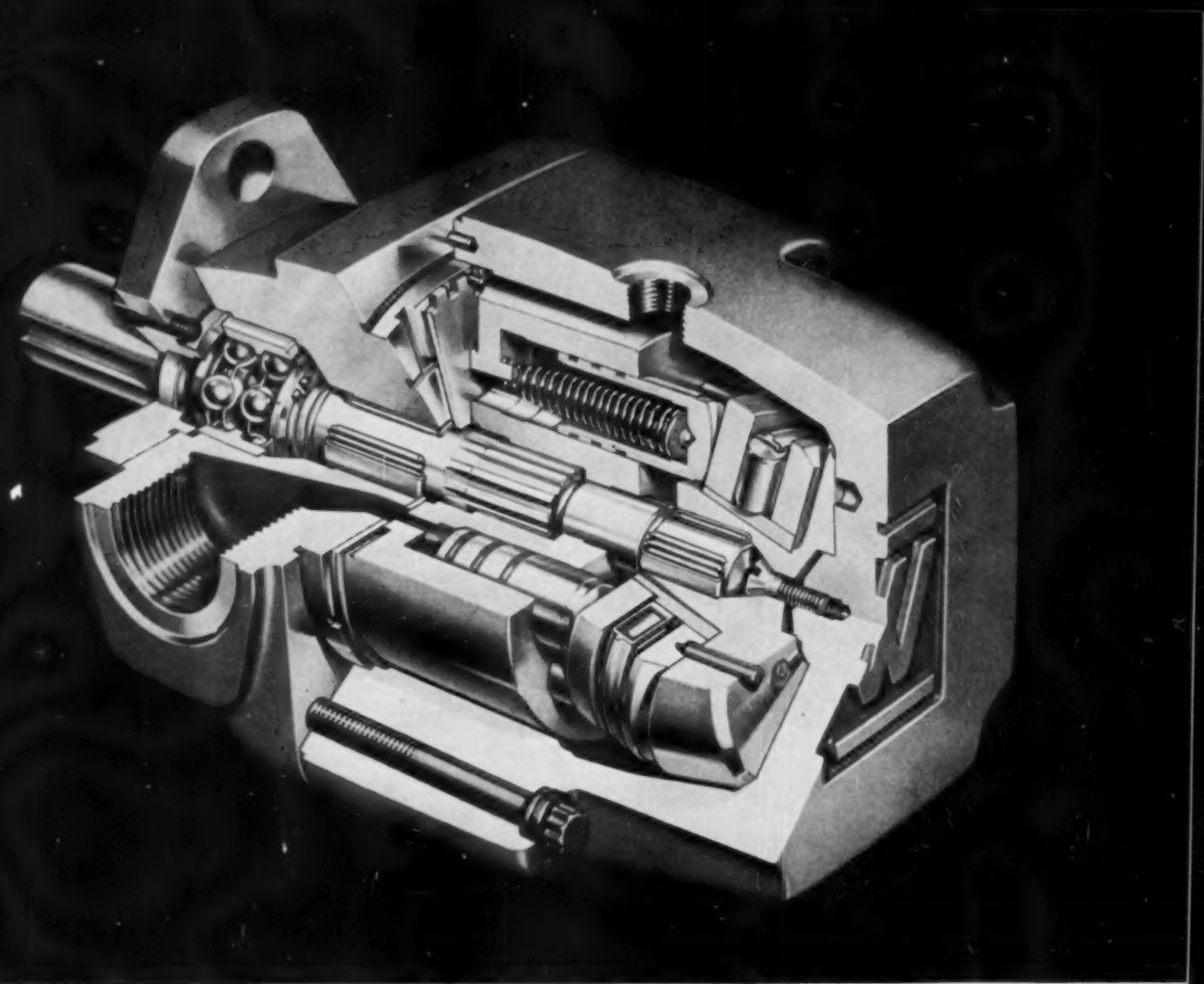
But it's a big part of what you can get by entering the 1961 Fluid Power Prize Paper Contest. Cash awards total $1400. Along with the money, you get recognition for yourself and your company—awards are presented at the National Conference on Industrial Hydraulics in October. Papers are published in Hydraulics & Pneumatics.

You can submit a paper dealing with any phase of product or equipment development, new applications, circuit and component design, or fundamentals.

This is a contest of ideas, not writing ability. Photographs, drawings, tables, or graphs can be used to help your presentation.

Get details by checking the Contest Box on the Reader Service Card inside the back cover of this issue.

Circle **125** →



WEBSTER'S NEW C3F PISTON MOTOR AND PUMP

compact, simple design ■ exceptionally serviceable!

This new hydraulic power unit — developed especially for the machine tool field — features unique application and servicing advantages. Examples: (1) small "package" to fit in close quarters — SAE "A" size mounting can be used with easy access to both mounting holes; (2) simplest axial-type piston pump on the market — fewest parts, fewer potential trouble spots, greater economy; (3) easily serviced — all critical moving parts can be readily replaced in the field. Shaft can be exchanged by disassembling seal end only; (4) unit can be disassembled and the rotation reversed in the field — can be arranged for use as a dual rotation motor; (5) variety of mounting styles — mounting plate and seal assembly is a separate piece and can be furnished in several mounting styles; (6) drive shafts are available with keyways or splines.

The C3F Series can be used as a hydraulic motor (remote rotary locations, screw feeds — anywhere an electric motor might be used) or as a hydraulic pump. . wherever high torque and smooth, steady force are required. It is available in four sizes — from .72 to 1.81 cubic inches per revolution. Capacities range from 3.3 to 8.5 gpm at 1200 rpm; 7 to 18 gpm at 2400 rpm.

C3F SERIES

FIXED DISPLACEMENT
AXIAL-TYPE PISTON
MOTORS AND PUMPS

Drive: direct, gear or belt

Displacements: four sizes; .72, 1.09, 1.45, 1.81 cu. in. per rev.

Porting: Side ports — horizontal or vertical — handle 1" NPT inlet or 1¼" "O" ring straight thread

Capacity: 3.3 to 8.5 gpm at 1200 rpm
7 to 18 gpm at 2400 rpm

Speeds: to 3000 rpm

Pressures: continuous duty 3000 psi, intermittent rating to 3500

When used as motor:

Torque range (theoretical): four sizes; 11.52, 17.28, 23.04, 28.80 inch pounds per 100 psi

Output: 5.5 to 14 hp. at 3000 psi at 1200 rpm
11 to 28 hp. at 3000 psi at 2400 rpm

OIL HYDRAULICS DIVISION
WEBSTER ELECTRIC
RACINE · WIS

franklin adv. H127A

YOU REDUCE COST WITHOUT SACRIFICING QUALITY

when you specify B&W Lectrosonic J.I.C. Hydraulic Line Tubing

J.I.C. Standards for hydraulic fluid line applications now permit the use of welded or seamless steel tubing on an equivalent basis. B&W Lectrosonic® welded carbon steel tubing meets all such J.I.C. Standards—and has been proved by 6 years of rugged B&W field testing. What's more, B&W Lectrosonic tubing is produced under the most rigid quality control procedures in the industry. Tests are made before, during and after manufacture. The key phase: 100% ultrasonic inspection of the weld in line production. The result: superior electric-resistance welded tubing that does the job of seamless while it maintains the low cost advantages of welded.

See how B&W Lectrosonic tubing can meet your hydraulic line requirements. Just call your B&W District Sales Office or write for Bulletin T-435. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-1009-M

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

Circle 28 on Reader Service Card

Circle 82 →

FREE THIS VALUABLE BOOKLET

Packed with 24 pages of data on new ways to more economical more productive Fluid Power!

You can use Boosters to particular advantage in:

Pressing	Stamping
Shearing	Marking
Punching	Crimping
Welding	Blanking
Riveting	Clamping
Crimping	Bending
Embossing	Molding
Feeding	Testing
Laminating	And similar
Compressing	applications

For prompt personal service, call our Engineering Dept. at Porter 6-3400 Bensenville, Ill. Call "collect," person to person (at our expense).

Exactly how do Boosters save space, weight, air, cut costs, increase efficiency, reduce maintenance? How do they provide smooth hydraulic power (up to 10,000 psi or more) from your shop air and maintain pressure without heat generation or additional power consumption? Exactly how and where are they now being used? The whole absorbing story is told in color—along with full information on available models, dimensional data, pricing, etc.—in this new interesting booklet specially prepared for busy, time-short designers, engineers, and production men. *Write today for your free copy.*

R

MILLER FLUID POWER

DIVISION OF FLICK-REEDY CORPORATION

7N017 York Road, Bensenville, Illinois

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

NEW PRODUCTS

Circle the numbers on the Reader Service post card for more information

AIR ROTARY ACTUATOR

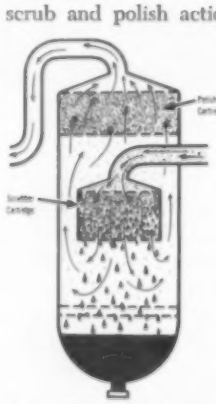
Miniaturized, high speed unit has no shaft seals, requires no linkages. Action on output shaft is direct.

Low air displacement requirements allow system size reductions. All moving parts are enclosed.
Specifications: Completes 90-deg stroke in 30 to 40 milliseconds. Fits a 1¾" by 2" package. 0.16 cu-in. air displaces its piston. Torque at 120 psig is 6.5 in.-lb.
Designation: Series 50.—*Ledex Inc., Dayton, Ohio.*

Circle **300** on Reader Service Card

COALESCENT ACTION AIR FILTERS

Uses scrub and polish action. Air



flows down through wet filter bed. Mist and fog particles coalesce and combine into drops which fall into sump at bottom. Cartridges are disposable. Complete removal of impurities from air.
Specifications: Flow rates from 20 to 200 cfm. Pipe sizes from ¼" to 2".—*King Engineering Corp., Ann Arbor, Michigan.*

Circle **301** on Reader Service Card

POPPET VALVE

Quickly releases static air pressure from pilot chamber of bleeder type air-operated valves quickly and completely. Poppet remains unseated until all static air is released, then reseats though plunger re-

mains depressed. Manual or mechanical operation. Four way valve (bleeder type) can be actuated in opposite direction even though poppet valve plunger is still depressed.
Specifications: Length 2¾", travel 3/16". ¼" NPT inlet.
Designation: 750 RV.—*Novi-Matic Valve Div., Novi Tool & Machine Co., Novi, Mich.*

Circle **302** on Reader Service Card

FLANGE HEAD FITTINGS

Flange head ends and bent tube fittings with 37 degree swivel nuts. Head has O-ring groove.
Specifications: Flange head fittings of straight connector, 45 and 90 degree elbows from ¼" to 2" I.D. Bent tube swivel nut fittings in 45

and 90 degree elbows and long 90 degree elbow, for hose from ¼" to 1" I.D.—*Parker-Hannifin Corp., Cleveland.*

Circle **303** on Reader Service Card

10,000-PSI VALVES

For air, oil, and water. 2-way, 3-way, and 4-way with closed and open centers. Noncorrosive internal parts. One piece stainless steel body. Sliding seals and selector disc are stainless steel honed optically flat for tight sealing.
Specifications: 10,000 psi, 15,000-psi surge. Burst pressure 30,000

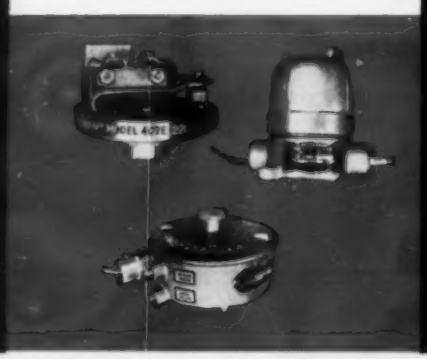
psi. Sizes ¼" to 1" with choice of internal pipe or internal straight (gasket seal) threads.—*Republic Mfg. Co., Cleveland.*

Circle **304** on Reader Service Card

For more NEW PRODUCT reviews turn to page 130

AN IMPORTANT MESSAGE TO BUYERS OF PRESSURE ACTUATED SWITCHES

Effective April 1, 1961, Meletron Corporation resumes the direct distribution of its Pressure Actuated switches and allied products



There are several reasons why Meletron Corporation has decided to take this action. Here are four of them: (1) To furnish better technical service to our customers. (2) To maintain a closer personal relationship between the company and users of Meletron products. (3) To provide faster delivery of stock items. (4) To enable us to make engineering assistance more readily available to those with a special pressure sensing application.

Warehouses contain an ample inventory of standard finished products. Shipments are being made direct from the factory in areas where distribution plans are still in the formation stages. Stock points are being established in all major industrial areas as rapidly as possible and there will be no delivery delays during the transition period.

Since 1940, Meletron has manufactured pressure actuated switches for aircraft, industry, and ground support equipment. These units are available for corrosive and non-corrosive service where pressure ranges are from zero to 15,000 psi. They are resistant to extreme temperature, vibration, shock and acceleration. For accuracy and reliability there are none better. *Meletron is capable of supplying every pressure actuated switch that has been or is currently being used.* We hope you will continue to let us serve you.

For further information and catalog, write, wire or call—

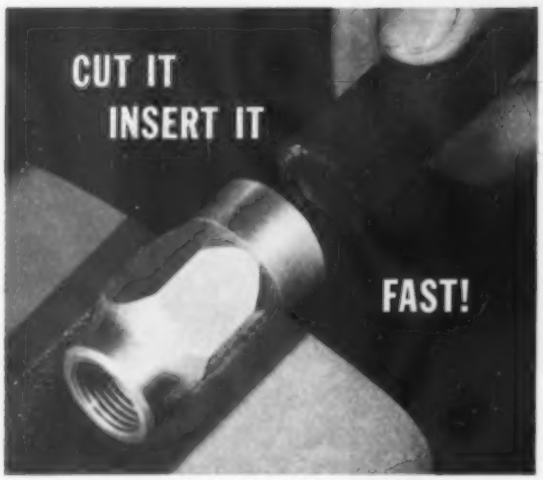
MELETRON CORPORATION

950 N. Highland Avenue, Los Angeles 38, California • HOllywood 3-4841

Circle **81** on Reader Service Card

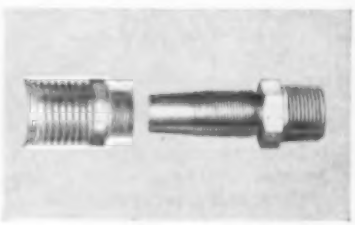
Save Hose Replacement Dollars

Using PARKER Fittings with PARKER Hose to make Replacement Assemblies Faster



Installing Parker "Hoze-lok®" Fittings on Parker "No-Skive" Hose . . . NO SKIVING!

Installing ordinary fittings on ordinary rubber-covered hose . . . First, this messy skiving job.



Design of the "Hoze-lok" socket (left) makes the difference. The deep-tapped threads accept the **controlled thickness** rubber cover of Parker "No-Skive" Hose as they plow their way down to the wire braid of the hose. The rubber is displaced, not removed.

Just screw the hose in counter-clockwise, by hand. The rubber cover fills completely the space between each thread. It both protects and cushions the wire braid, eliminating a major cause of hose failure. A little Parker "Threadlube" is needed here.

The nipple, which is also the hose end fitting, screws in last, clockwise, in the usual way. You are now ready to make up the other end of your Parker No-Skive Hose Assembly. This method is not only faster; it gives you a better assembly. See next page.

You can install a Parker "Hoze-lok" Fitting on small-diameter Parker "No-Skive" Hose in 60 seconds. On 3/4" Parker hose, it takes 2 minutes or less. On very large sizes, allow 5 minutes per fitting. Hose replacement time is reduced to minutes the Parker No-Skive Way!

...*the* Parker No-Skive Way

Why Parker No-Skive Hose Assemblies Last Longer

BETTER PROTECTION FOR THE HOSE AT ITS POINT OF GREATEST STRESS

Most hose failures result from flexing. Ordinary hose, skived to the bare wire at the critical point where the first thread of the hose fitting bears directly on the wire braid, fails right there. As our picture shows, the leading thread of Parker "Hoze-lok" Fittings cannot reach the wire. The cushioning effect of the compressed rubber between the threads reduces the stress concentration at this point. Gripping by direct contact between the deep-tapped "Hoze-lok" threads and the wire braid occurs well within the fitting, where no flexing occurs.

Actual tests prove the effectiveness of this better design feature. Parker "Hoze-lok" assemblies on Parker "No-Skive" Hose rarely fail at the fitting, even when stressed to the burst point.

HOW PARKER DEVELOPED A BETTER HOSE TO MAKE THESE SAVINGS POSSIBLE

Parker "Hoze-lok" Fittings can be used with any hose, but you still have to skive ordinary rubber-covered hose, even with "Hoze-lok" fittings. Parker "No-Skive" Hose, however, is made to rigid specifications that limit and *control* the thickness of the cover to the exact amount of rubber that the corresponding size of "Hoze-lok" fitting will accept, when attached without skiving.

In all other characteristics, from the inner liner to the OD of the outermost wire braid, Parker "No-Skive" Hose conforms to S.A.E. specifications. In addition, because only a better grade of rubber compound can be extruded to Parker's exacting *controlled thickness* specification, the increased resistance to abrasion of the Parker "No-Skive" rubber cover results in a better hose.

PARKER HANNIFIN CORPORATION

Parker FITTINGS AND HOSE DIVISION

17325 Euclid Avenue • Cleveland 12, Ohio

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

ARRANGE NOW FOR A PARKER NO-SKIVE DEMONSTRATION IN YOUR OWN PLANT OR OFFICE

Gentlemen: We would like to see the Parker No-Skive Way to make up replacement hose assemblies demonstrated, without any obligation on our part, of course.

Please ask your salesman or nearest "Hoze-lok" distributor to get in touch with me:

Name_____

Title, Department or Division _____

Company_____

Address_____

City_____ Zone_____ State_____

We use hose for_____

3079-PH

NEW LITERATURE

Circle the numbers on the Reader Service post card for free copies

HOSE FITTINGS

Color-coded 8-page catalog designed to make ordering of hose fitting assemblies easier. Covers detachable and reusable hose fit-

tings and assemblies for medium and high pressure industrial uses. Feature single wire braid hose and fittings, double wire braid hose and fittings, hose adapters, swivels, and Single wire, stripped cover hose and fittings.—*The Lenz Co., Dayton, Ohio.*

Circle **400** on Reader Service Card

AIR DRYER

Bulletin 9300 illustrates operation of series-E unit. Dew point chart and installation procedure. Capacity 10 scfm at 100 psig and 100 F. Inlet and outlet connections ⅜" O.D. copper tubing.—*Hankison Corp., Canonsburg, Pa.*

Circle **401** on Reader Service Card

FITTINGS & FLANGES

Booklet covers seamless, welding fittings and flanges in carbon, alloy and stainless steels. Charts of standard sizes and schedules according to ASA B36.10 and ASA B36.19. Breakdown of dimensional tolerances. Illustrations, and chart of sizes and types. Bulletin FB-502A.—*Babcock & Wilcox, Tubular Prod. Div., N. Y.*

Circle **402** on Reader Service Card

HYDRAULIC ACCUMULATOR

Acts as a power storage chamber, pressure compensator, and eliminates surges and vibration. Six models for 3,000-psi service, four for 3,500-psi. Sizes from 1 pt to 2½ gal overall. Oil volumes from 29 to 575 cu-in. Port sizes ¼" to 1¼" NPT.—*Crescent Hydraulic Co., Allegan, Mich.*

Circle **403** on Reader Service Card

HYDRAULIC POWER UNITS

Pumping unit, 34" high, 16¼" O.D. Weight 180 lbs. 5-hp, 1800-rpm electric motor. Reservoir capacity 15 gal. Tripod legs mounting.—*Ontario Hydraulics, Ontario (Montclair), Calif.*

Circle **404** on Reader Service Card

BOUNCE-FREE SWITCHES

Series 1PB2000 used with high-speed electronic components (less than 1 microsecond). Positive and negative outputs from 100 ohms load up. Output voltage is 1 to 4% less than input. *Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

Circle **405** on Reader Service Card

SHAFT COUPLINGS

Bulletin 4100 gives line of torsionally resilient couplings. Illustrations and dimensions. For either horizontal or vertical applications. Wide-shoulder seal ring keeps cover in position. Two covers are identical. Up to 130,000 hp at 100 rpm.—*The Falk Corp., Milwaukee.*

Circle **406** on Reader Service Card

METAL O-RING SLIDE CHART

Covers ring diameters from ¼" to 50". Includes specs for plain, plated, and coated rings. By setting slide rule at desired nominal O.D. for any standard ring, proper installation dimensions are determined. Data given for calculating dimensions for non-standard rings. —*The Advanced Products Co., North Haven, Conn.*

Circle **407** on Reader Service Card

LINEAR POSITIONER

For positioning air cylinders, electro-mechanical drives, and indicating positions of mechanical elements. Cylinder applications include rapid advance-slow speed, and start, stop, proceed motions. As an indicator linked mechanically with control devices, unit feeds a signal to indicate position of the attached device. Temperatures from −40 to 180 F. Current rating at 125 or 250 vac, 5 amps; 30 vdc, 3 amps. Bulletin 500A shows illustrations, line drawings and charts.—*Hanna Engineering Works, Chicago, Ill.*

Circle **408** on Reader Service Card

You can win up to $500 by entering the
1961 FLUID POWER PRIZE PAPER CONTEST
For details circle 339 on reader service card

BALL VALVE

Forged naval bronze ball valve for water, oil or gas service. Can be quickly opened with quarter turn of handle. Buna-N seats. Sizes from ½" to 2". To 9½" overall length. 300 psi, 250 F. Bulletin DH-38.—*R-P&C Valve Div., American Chain & Cable* Co., Inc., Reading, Pa.

Circle **409** on Reader Service Card

Continued on page 64

NEW ADDITION TO A GREAT LINE...

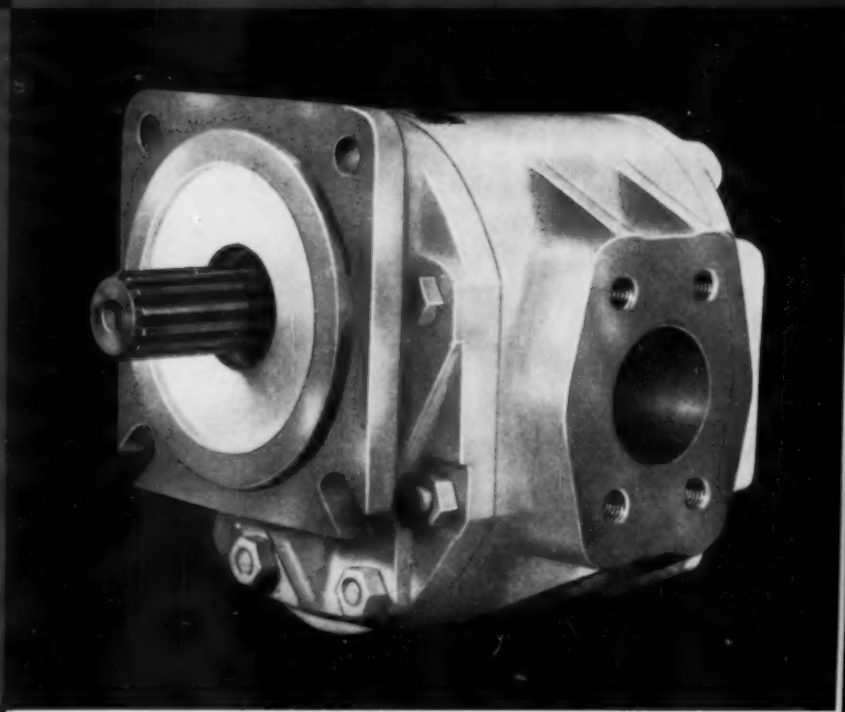
WOOSTER **P4** SERIES

HYDRAULIC GEAR PUMPS

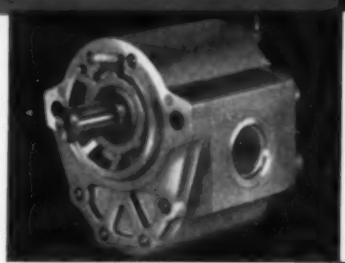
- **CAPACITIES 25.0 to 57.0 GPM at 2000 RPM and 2000 PSI**
- **DISPLACEMENT 3.2 to 7.3 CU. IN.**
- **SPEEDS to 2500 RPM**

Unique Controlled Pressure Loading* Principle Lengthens Life of Pumps

Controlled pressure back of the bearings is carefully calculated to exert only enough hydraulic force to counter-balance *exactly* the internal hydraulic forces pushing against faces of bearings, whether pump is operating at high or low pressure, high or low speed. This eliminates wear, prevents undue loads.



*U.S. PATENTS 2420622, 2823615, 2824522 (OTHERS APPLIED FOR)

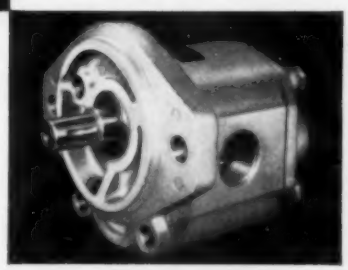


FEATURES OF P2-P3-P4 SERIES:

Special alloy tin-aluminum bearings as used in heaviest-duty industrial engines, all interchangeable . . . Double lip shaft seal . . . Hardened and ground alloy steel gears and shafts . . . High quality, high tensile aluminum bodies and covers for light weight . . . Variety of porting, mounting and drive arrangements.

P3 SERIES

Capacities 8.0 to 21.0 GPM at 2000 RPM and 2000 PSI,
Displacement 1.0 to 2.7 cu. in.
Speeds to 3000 RPM.



P2 SERIES

Capacities 1.7 to 7.8 GPM at 2000 RPM and 2000 PSI,
Displacement 0.2 to 0.9 cu. in.
Speeds to 4000 RPM.

WOOSTER B-W DIVISION

WRITE, PHONE OR WIRE OUR ENGINEERING DEPARTMENT

WOOSTER DIVISION

BORG-WARNER CORPORATION, WOOSTER, OHIO

INDUSTRIAL HYDRAULICS / *EXPORT SALES—BORG-WARNER INTERNATIONAL 36 SOUTH WABASH AVE., CHICAGO 3, ILL.*

IT'S A BETTER PRODUCT WHEN BORG-WARNER HAS A PART IN IT

HIGH
TEMPERATURES?
COMPOUNDS
EFFECTIVE TO
+550° F
TECHNICAL MEMO ON LINEAR COMPOUNDS
8251-70—8250-85—8252-90
. . . outstanding for O-Rings, V-Rings and U-Cups.
• truly effective sealing at temperatures to +550°F
• suitable for use with a wide variety of fluids, including oils, fuels, water and diverse chemicals
• good resistance to compression set and wear
FLUIDS COMPATIBLE WITH THESE COMPOUNDS
Acetone • Acetylene Tetrabromide • Air • Amyl Alcohol
Aniline • Arochlor 1248 • Benzine • Carbon Disulfide • Carbon
Tetrachloride • Chloroform • Cyclohexane • Dowtherm A
Styrene • Sulfuric Acid • Toluene • Benzol • Dry Chlorine Gas
Ethyl Alcohol • Ethylene Dichloride • Ethylene Glycol • Gasoline
GE 81406 • Hexane • Isobutyl Alcohol • JP-4 and JP-5 Fuels
Kerosene • Methylene Dichloride • Trichloroethylene • Turpentine • Water • MIL-F-25558A Fuel • MIL-L-7808 Lubricants
MIL-O-5606 Hyd. Fluid • MLO-8200 Hyd. Fluid • MLO-8515
Hyd. Fluid • Naphtha • Nitrogen • OS 45-1 Hyd. Fluid • Petroleum Base Oils • Silicone Fluids • Steam • Wet Chlorine Gas
For complete technical data—including list of incompatible fluids, request Bulletin 56700-1. Linear Inc., State Road and Levick St., Philadelphia 35, Pa.
PERFECTION IN RUBBER
LINEAR
Circle **71** on Reader Service Card

NEW LITERATURE

POWER-TOOL RETOOLING

Bulletin shows how planned annual retooling program can increase output of screw-driving, grinding, nut-running, drilling, and similar operations. Offers formulas based on field experience. Slide-rule computer shows how man-hour output can be increased and money saved, without adding operators.—*Ingersoll-Rand Co., N. Y.*

Circle **410** on Reader Service Card

ROTARY OIL PUMPS

For rugged service in transfer, injection, gathering, and power applications. 300 series, helical gears, to 300 psi. 700 series, gerotor, to 1000 psi. From 20 to 175 gpm. Viscosity range, 40 ssu to 50,000 ssu. Flanged port connections. Replaceable wear plates. —Bulletin P15.—*Brown & Sharpe Mfg. Co., Hydraulics Div., Providence, R.I.*

Circle **411** on Reader Service Card

BALLISTIC FLARER

Model B820 is a cartridge-actuated device for forming flares in tubes of any wall size or material. OD range from ¾" to 1¼". Flares conform to SAE hydraulic 37 degrees and J.I.C. standards. Bulletin 4392B14. *Parker Fittings and Hose Div., Parker-Hannifin Corp., Cleveland.*

Circle **412** on Reader Service Card

PLUMBING PARTS MANUAL

Bulletin 921 is prepared for design engineers and contains specs on adapter couplings, bushings, elbows, tees, hose assemblies and brackets. Fold-out page diagrams Dryseal thread types. Methods of Dryseal pipe thread gaging are given, as well as definitions of series symbols, and differences in pipe threads.—*Lincoln Engineering Co., Original Equipment Sales Div., St. Louis.*

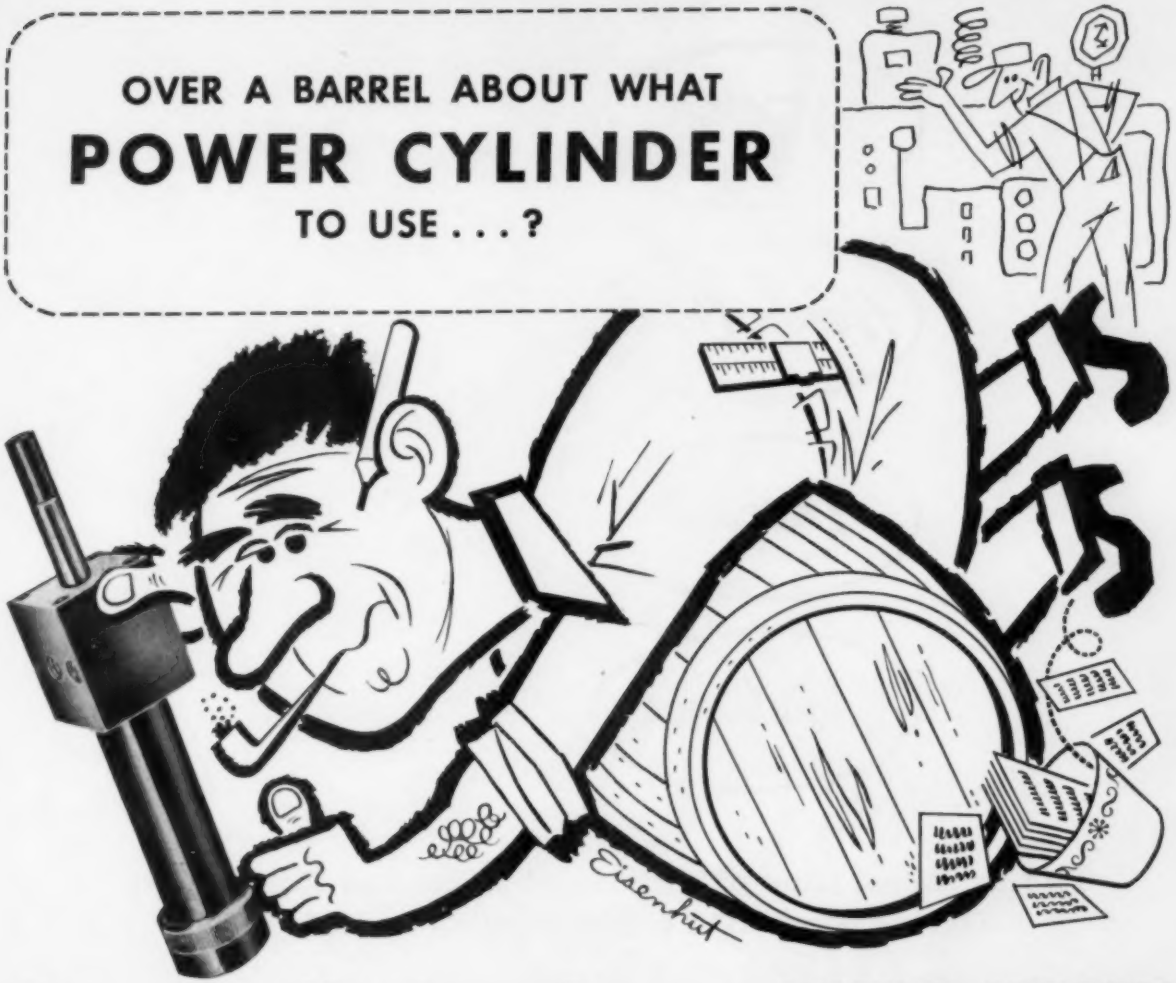
Circle **413** on Reader Service Card

For more reviews of FREE LITERATURE turn to page 138

OVER A BARREL ABOUT WHAT

POWER CYLINDER

TO USE . . . ?



Then Specify *Sure Power* ANKER-HOLTH

HERE'S WHY ANKER-HOLTH POWER CYLINDERS SAVE YOU TIME . . . TROUBLE AND MONEY

- Simplified Maintenance
- All Mountings Available
- Bores 1" to 48"
- Strokes to 40'
- Reliability Through Military-Accepted Quality Control Program
- Built to J.I.C. Specifications
- Nationwide Engineering Service On Call
- Experience Proved in Every Major Industry
- World's Widest Selection of Standard Power Cylinders

SEND FOR COMPLETE CATALOG

ANKER-HOLTH DIVISION
THE WELLMAN ENGINEERING CO.
2723 Conner Street, Port Huron, Mich.

☐ Please send me your complete catalog

☐ Please send me information for the following application: _____

NAME _____

COMPANY _____

ADDRESS _____

F-1

ANKER HOLTH

DIVISION, THE McDOWELL-WELLMAN COMPANIES

The Broadest Line of Industrial Filtration Equipment Offers over 4311 Filter Models and Media . . . . . .

For any filtration need — from Air to Zinc Cyanide — look to CFC Filters to improve product quality, cut maintenance and production costs, protect valuable equipment and reduce down time.

Fulflo Filters, for precise filtration of liquids and gases, have a choice of media that includes natural and synthetic fibers, pleated paper, sintered or woven metals and porous ceramics;

Honan-Crane Filters for industrial oils — with interchangeable pleated paper, cellulose fiber and fuller's earth media; **Delpark** Filters and Filter-Matics for continuous clarification of metal-working coolants and other industrial liquids — with paper, wire cloth, synthetic and natural woven fiber media;

Michiana Filters — with fiber media — for gas and diesel engine lubricating oils and fuels.

Write for catalog or engineering assistance to Department HP.

COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

Circle **31** on Reader Service Card

Circle **121** →

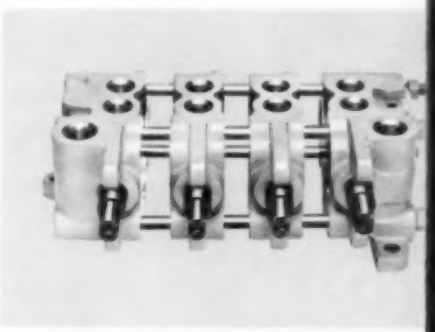
Feather Control **OF THE LOAD**

NEW FROM VICKERS

New Vickers Directional Valve Outperforms All Others

Greater capacity, improved metering provides smooth, precise, jerk-free load control never before possible . . . many other benefits, too.

TO manufacturers of materials handling, construction and other hydraulically operated mobile equipment, the new design of the Vickers CM11 valve offers startling opportunities. Truly a customer and market oriented product design, it meets all basic needs of the changing mobile equipment industry today and for the foreseeable future. In some cases it permits equipment progress previously impractical. To highlight a few benefits of the new CM11 design:



2500 psi OPERATING PRESSURE

The new CM11 Series valve offers the highest operating pressure for its size in the industry . . . *2500 psi!* Yes, this greater pressure is practical without increasing over-all dimensions, thus making the new design completely interchangeable with previous Vickers models. Even though more force is available to do more work because higher pressures can be handled, standard high pressure fittings and hoses are currently available to meet system requirements.

NEW LOW PRESSURE DROP

The new Vickers CM11 series design has substantially reduced pressure drop at all rates of flow . . . 25% less drop! As an example, pressure drop of these units at 15 gpm is no greater than on former Vickers designs at 12 gpm . . . even less than that of other designs! (see Fig. 1)

This means more work capacity on every type of equipment with less horsepower wasted in the valve itself. Less heat is generated at the valve and, on electric trucks, valuable battery ampere-hours are conserved to do useful work.

FINEST METERING YET

Due to design changes incorporating a new specially-developed casting, new Vickers CM11 valves feature the finest metering characteristics ever achieved. The result is true feather control of the load at all times . . . the jerky, rough control of all other valves is now a thing of the past.

This improved metering is the result of a number of material and design factors which give smoother spool action under all conditions and much more precise control of oil flow.

FLEXIBLE INSTALLATION

The new CM11 valves are completely interchangeable with previous Vickers models. And still featuring multiple unit construction (a Vickers first) you can assemble as many control units as you need . . . even add to them later in the field.

NO HIGHER PRICE

All the advanced features above, along with many more not covered here, all are available without any increase in price! Improved manufacturing techniques, new tooling and increased demand give you the greatest value in valves ever offered.

FOR FULL FACTS

To get all the facts, all the features, all the answers to your own valve requirements simply write, or wire collect, to address below. Ask for Bulletin M-5112.

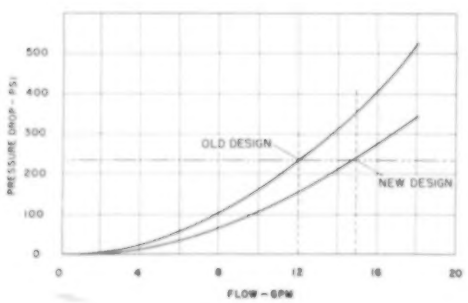


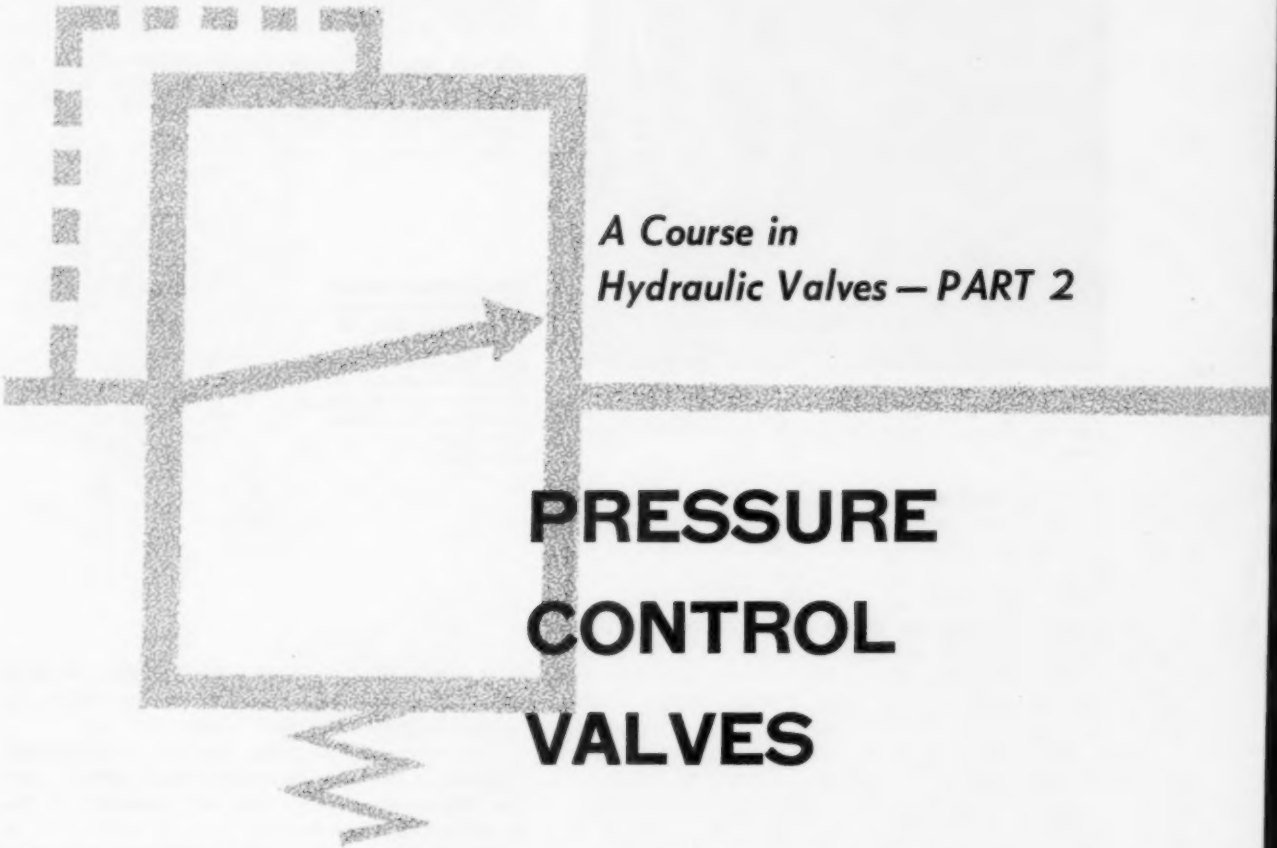
Fig. 1

VICKERS

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Mobile Hydraulics Division
ADMINISTRATIVE AND ENGINEERING CENTER
DETROIT 32, MICHIGAN, U. S. A.

Hydraulics & Pneumatics

APRIL 1961



A Course in Hydraulic Valves — PART 2

PRESSURE CONTROL VALVES

This is the second in a series of three articles on hydraulic valves. The first article appeared in the February 1961 issue of HYDRAULICS & PNEUMATICS *and covered directional control valves. The third article will be published in the June issue and will describe flow control valves. The series explains basic design and performance characteristics. It presents important factors in selecting the proper valve for a particular application.*

PRESSURE control valves limit system pressure, reduce pressure in any part of a circuit, unload a pump during part of a machine's cycle, or determine the pressure at which oil enters part of a circuit. They are called relief, pressure reducing, unloading, sequence, or counterbalance, depending on their function in a circuit.

RELIEF VALVES

Hydraulic components and systems are rated for a specific maximum operating pressure. Exceeding this pressure may damage the components or develop too great a force for the work being done by the system. Relief valves prevent pressure from building up beyond this safe limit.

There are two general types of relief valves: direct acting, and pilot operated.

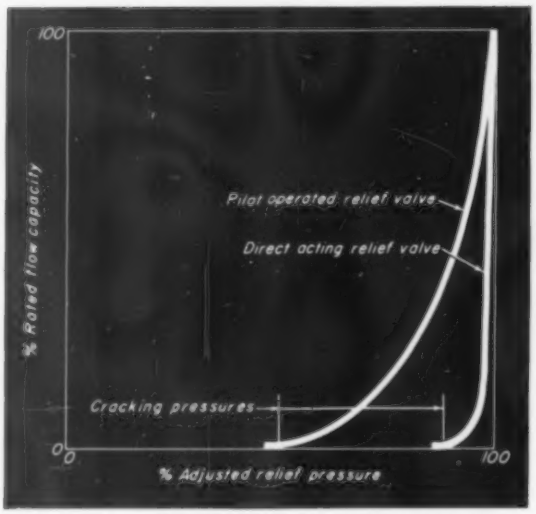


FIG. 1. CRACKING PRESSURE for pilot-operated relief valves is within 10% of the adjusted relief pressure. Direct acting relief valves generally start relieving at a considerably lower pressure.

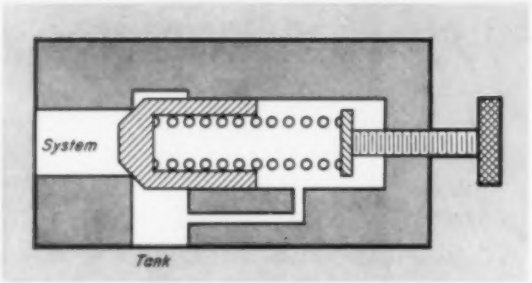


FIG. 2. DIRECT-ACTING RELIEF VALVE prevents flow through the valve until force of system pressure on the poppet overcomes the adjustable spring force and downstream pressure.

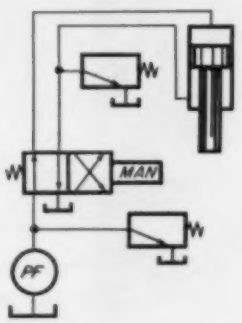


FIG. 3. TWO RELIEF VALVES limit high pressure for extending the cylinder, and low pressure for retracting and holding the cylinder up. Heat is reduced and power saved by holding the cylinder up at low pressure.

• **Direct Acting**—The simplest relief valve uses a poppet or ball exposed to fluid pressure on one side and opposed by spring force on the other side, Figure 2. A tank port on the spring-loaded side of the valve returns fluid to the reservoir. When pressure increases enough to overcome spring force, the poppet lifts, connecting pressure fluid to the tank port. Fluid flows to tank until force on the poppet from system pressure is less than spring force. The spring then closes the valve.

The pressure required to start fluid flowing through the valve is called *cracking pressure*. A higher pressure is needed to open the valve fully. The difference between cracking pressure and full open pressure is called *differential*.

Spring-loaded poppet valves are generally used for small flows. They don't leak below cracking pressure and have a fast response, making them ideal for relieving shock pressures. They are often used as safety valves to prevent damage to components from high surge pressures, or to relieve pressure caused by thermal expansion in locked cylinders.

If poppet relief valves are required to operate often, chatter caused when the valve relieves may damage the seat. Here is one theory on the cause of chatter.

When the poppet lifts, fluid starts flowing and accelerates near the valve opening. The area subject to full fluid pressure when the valve was closed is now subject to a changed pressure at its periphery. A combination of fluid pressure and velocity combined with some overtravel of the poppet in the opening direction, results in too much fluid flow, subsequent pressure drop, and return of the poppet toward the seat. The rapid repetition of this cycle may produce anything from a pulsation to a high pitched whistle. Some reverse acting relief valves use a dashpot to cushion the valve's closing and eliminate chatter.

The differential between cracking and full open pressure on spring-loaded poppet relief valves is high. For this reason they are not recommended for close pressure control.

Relief valves are also made to relieve flow in either direction. Fluid pressure at one port opens the valve by acting directly on the solid plunger. Fluid pressure at the other port acts on a shoulder on the plunger to open the valve.

Another type of direct acting relief valve is the guided piston type. In this valve a sliding piston, rather than a poppet, connects the pressure and tank ports.

System pressure acts on the piston and moves it against spring force. As the piston moves, it uncovers a tank port in the valve body.

The valves have a fast response and may chatter. They can be damped to eliminate chatter, but this also slows valve reaction time. They are reliable and can operate with good repetitive accuracy if flow does not vary widely. Valves with hardened steel pistons and sleeves have a very long service life. They may leak slightly below cracking pressure unless there are seals used on the pistons.

Guided piston relief valves are generally used for

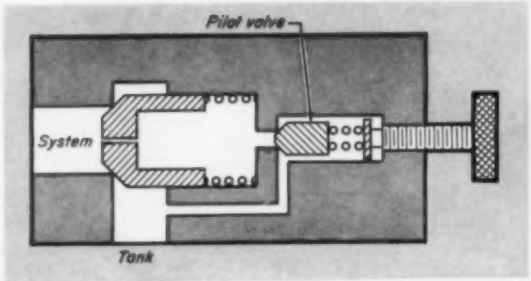


FIG. 4. PILOT-OPERATED RELIEF VALVE has an orifice through the piston and is held closed by the force of a light spring and system pressure acting on the larger piston area at the spring end. When system pressure rises to overcome the force of the pilot valve spring, the pilot valve opens. Flow through the orifice creates a pressure drop across the piston. Pressure differential unseats piston and opens valve.

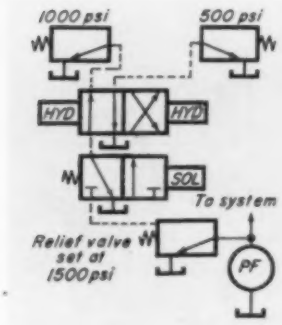


FIG. 6. EITHER OF TWO PILOT RELIEF VALVES vents the main system relief valve to give a 3-pressure system. Directional control valves select one of the pilot reliefs or block the main relief valve vent line. The pilot valves may be remote from the main relief valve.

pressures under 800 psi, although they can be made with heavier springs for higher pressures. The heavier springs give the valve a greater differential and increase valve size.

A variation of the guided piston relief valve is the differential piston relief valve. It is called *differential piston* because the pressure acts on an annular area which is the difference between two piston diameters. The annular area is smaller than the valve's seat area. This permits using a smaller spring than would be needed if pressure acted on the entire seat area. They have a lower pressure differential than poppet or guided piston relief valves.

• **Pilot Operated**—Relieving over a wide flow range with very little differential requires pilot operation of the main relief valve. Pilots are generally built into the main valve. However they may be located at some remote point in the system and connected to the main valve with pipe or tubing.

The pilot section is a small, spring-loaded relief valve which controls the main valve, Figure 4. System pressure acts on the bottom of the main valve piston, and through an orifice, on top of the piston and the pilot poppet. The pressure on top acts on a larger area, providing a force tending to close the valve. A light spring provides initial position of the piston against

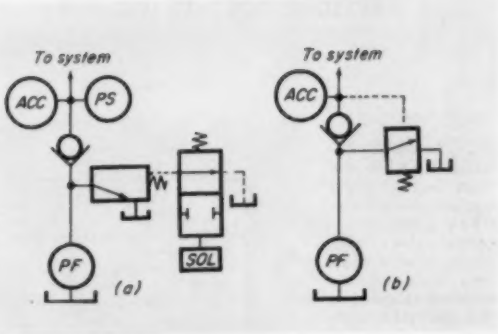


FIG. 5. PILOT-OPERATED, RELIEF VALVE UNLOADS PUMP (a). The pump operates only long enough to charge the accumulator. It then unloads through the vented relief valve. Vent from the pilot-operated relief valve connects to tank through a solenoid shut-off valve. A pressure switch energizes the solenoid valve when system pressure falls and de-energizes the valve when the accumulator is charged to full pressure. Unloading valve (b) actuated by system pressure unloads the pump to tank when system pressure reaches valve setting. The check valve prevents unloading the system through the valve. The accumulator holds pressure in the circuit.

the valve seat, preventing flow through the main valve.

When system pressure increases enough to overcome force of the pilot valve spring, the pilot valve opens. Fluid flows out of the pilot chamber faster than it can be replaced by flow into the chamber through the orifice. Pressure drop through the orifice makes pressure on top of the piston less than pressure on the bottom. This pressure difference opens the valve against the light spring force. The valve remains open until system pressure falls and allows the main valve to close. At this point the pilot valve closes, again balancing pressure on top and bottom of the main valve piston. The light spring then closes the main valve.

Pilot operated relief valves maintain a small pressure differential over a wide flow range. Usually cracking pressure is 90% or more of the pressure at full rated flow of the valve. They are generally smaller than direct operated relief valves for equivalent flows. Their response may be a little slower.

Relieving pressure of a pilot-operated relief valve may be controlled remotely by connecting the chamber on top of the main valve piston to a remote relief valve, Figure 5. Pressure is transmitted to the remote valve through the orifice in the main valve piston. The remote relief valve then acts in the same way as the built in pilot relief valve.

This arrangement can give a two-pressure system when the remote relief valve is connected through a 2-way shutoff valve. The built-in pilot valve is adjusted to relieve at a higher pressure than the remote relief valve. When the remote valve is selected (2-way valve open) system pressure is limited to its setting.

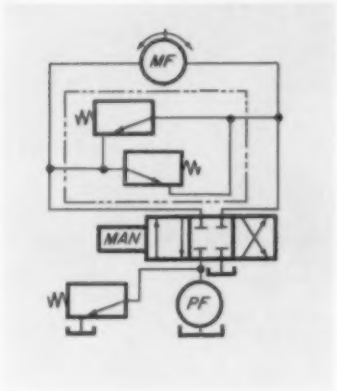


FIG. 7. DUAL RELIEF VALVE protects the fluid motor against overpressure when directional control valve centers. Fluid relieved from one side of the motor is returned to the other side. Without relief valve, inertia of motor's load would cause surge pressures.

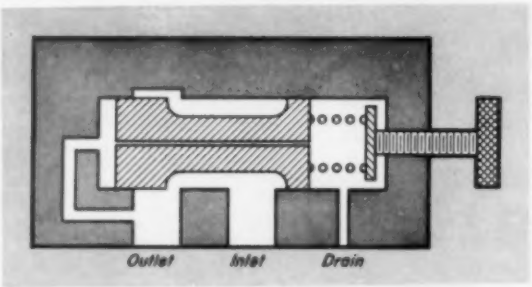


FIG. 8. DIRECT ACTING, PRESSURE REDUCING VALVE is held open by spring force. As reduced pressure at outlet port increases above the loading of the spring, it gradually moves the spool to the right, closing the valve, and increasing pressure drop across it. When valve closes completely, a small quantity of fluid drains through the spool to tank, preventing reduced pressure from increasing because of valve leakage.

Pilot operated relief valves may also unload a pump at low pressure, Figure 6. To do this, a venting line containing a shutoff valve connects the chamber on top of the main valve piston to the system reservoir. With the shutoff valve closed, system pressure is controlled by the main relief valve. When the shutoff valve opens, fluid drains from the chamber on top of the main valve piston to tank. System pressure acting on the bottom of the piston is opposed only by the light spring. Pump flow opens the main valve wide and unloads to tank at low pressure.

• **Dual Relief Valves**—High shock pressures occurring between directional control valves and cylinders or fluid motors when they stop or reverse may be quickly dissipated with dual relief valves. These have two relief valves built into one body, one relieving in each direction, Figure 7. Oil is relieved from one end of a cylinder or fluid motor to the other end. The valves may relieve at the same pressure, or each can be set for a different relief pressure. The valves are generally poppet or differential piston type to respond quickly to shock pressures.

• **Cascading Relief Valves**—Portions of many hydraulic circuits must operate at a lower pressure than main system pressure. It may be necessary to protect components which have low operating pressure ratings, or to control clamp or work pressure accurately.

One way to get a reduced pressure is by cascading relief valves. To do this, the tank port of the main system relief valve is connected to the pressure port on a second relief valve. Overflow from the second relief valve flows to tank. This arrangement provides fluid at a reduced pressure in the line between the two valves. The relief setting on the second valve determines the reduced pressure. This system will operate satisfactorily as long as sufficient fluid flows over the main system relief valve. If the high pressure circuit takes too much flow, the low pressure circuit will starve.

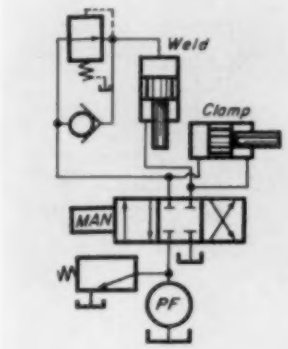


FIG. 9. PRESSURE REDUCING VALVE limits pressure for welding while clamping at the system relief valve setting.

PRESSURE REDUCING VALVES

The most practical components for maintaining secondary lower pressures in a hydraulic system are pressure reducing valves. These are normally-open, 2-way valves, sensing downstream pressure to close. There are two types, direct acting, and pilot-operated.

Direct acting pressure reducing valves are usually sliding spool design. Fluid flows from the valves' high pressure inlet to the low pressure outlet, Figure 8.

An adjustable spring holds the poppet or spool open. Reduced pressure acts on the poppet or spool to close the valve. Fluid flows unrestricted through the valve until force from the reduced pressure equals spring force. The spool or plunger moves, compressing the spring and restricting flow through the valve.

When the set pressure is reached, the valve closes except for a small quantity of fluid that bleeds from the low pressure side of the valve, usually through an orifice in the spool or body, through the spring chamber to the reservoir. This bleed-off prevents downstream pressure from increasing above the valve's setting because of spool leakage when the valve closes. The orifice controlling this bleed-off may be fixed

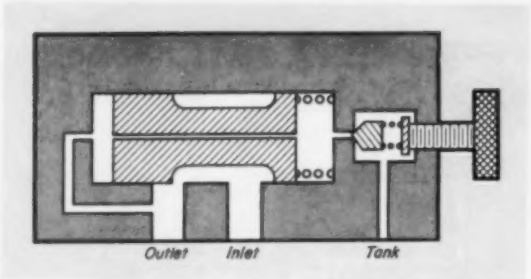


FIG. 10. PILOT-OPERATED, PRESSURE REDUCING VALVE has reduced pressure on both ends of the spool. A light spring holds the spool open. When reduced pressure increases to the spring setting on the pilot valve, the pilot valve opens. Fluid from the right side of the spool drains to tank. This causes a pressure drop across the spool that tends to close the valve. The valve will close partially until flow through it meets system requirements, and the spool again balances.

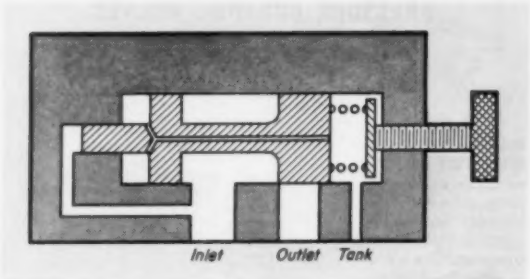


FIG. 11. SEQUENCE VALVE is a normally-closed, 2-way valve. It is held closed by an adjustable spring. Pressure at the inlet port acting on the left of the spool opens the valve against the force of the spring. The spring chamber drains to tank.

or adjustable. The spring chamber is always drained to the reservoir to prevent fluid pressure building up and holding the valve open.

Direct acting pressure reducing valves require a large envelope to provide space for the spring and adjustment. Also spring ranges are usually narrow. As in relief valves, a small pilot section may be added to control the main valve.

The spool or poppet in a pilot-operated, pressure reducing valve is hydraulically balanced by downstream pressure at both ends, Figure 10. A light spring holds the valve open. A small pilot relief valve, usually built into the main valve body, relieves fluid to the system reservoir when reduced pressure reaches the pilot valve's spring setting. This fluid flow causes a pressure drop across the spool or poppet. Pressure differential then moves it toward its closed position against the force of the light spring. The pilot valve relieves only enough fluid to position the main valve spool or poppet so that flow through the main valve equals the flow requirements of the reduced pressure circuit. If no flow is required in the low pressure circuit during a portion of the cycle, the main valve closes. Leakage of high pressure fluid into the reduced pressure section of the valve then returns to the reservoir through the pilot relief valve.

Pilot-operated pressure reducing valves generally have a wider range of spring adjustment than direct acting valves. They generally provide more repetitive accuracy. However, oil contamination can block flow to the pilot valve and the main valve will fail to open properly.

SEQUENCE VALVES

In hydraulic circuits with more than one cylinder it is often necessary to actuate the cylinders in a definite order. This can be done with limit switches, timers, or other electrical controls. It can sometimes be done by sizing cylinders according to the loads. The

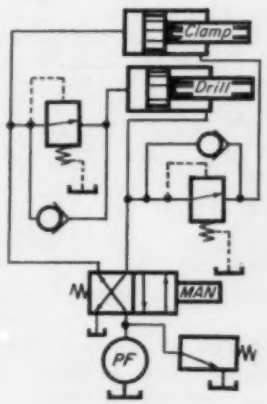


FIG. 12. SEQUENCE VALVES allow the clamp cylinder to extend before the drill cylinder. When the control valve shifts, the drill cylinder retracts first.

cylinder requiring the least pressure extends first. At the end of its stroke, system pressure increases and extends the second cylinder. This succession continues until all cylinders are actuated. However in many circuits space limitations and force requirements determine the size cylinder required. In this case a sequence valve may be used to actuate the cylinders in order.

Sequence valves are normally-closed, 2-way valves. They remain closed until pressure at their inlet port reaches a value set by adjusting a spring. At this pressure they open and allow fluid flow through the valve. They are similar to direct acting relief valves except their spring chambers are generally drained externally to the system reservoir, instead of internally to the outlet port as in the relief valves.

In the sequence valve, Figure 11, fluid from the system having priority connects to the inlet port. This fluid flows through a port in the valve body to a chamber where it acts on a reduced diameter of the spool. When pressure in the inlet circuit increases enough to overcome spring force, the valve opens. Fluid flows from the inlet to the outlet circuit. The spring chamber drains to the system reservoir. This bleeds off leakage flow, preventing fluid from filling the spring chamber and interfering with opening the valve. Sequence valves

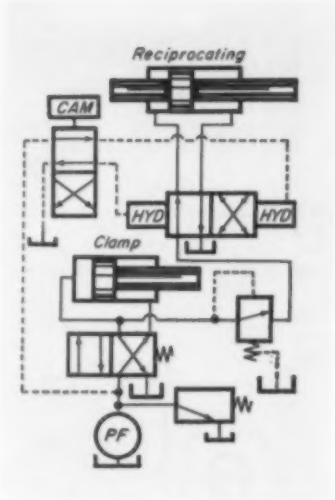


FIG. 13. SEQUENCE VALVE assures adequate pressure in the clamp circuit before reciprocating cylinder operates. This circuit is often used on machine tools. When the cylinder reaches the ends of its stroke it actuates the cam valve to reverse the pilot-operated directional valve.

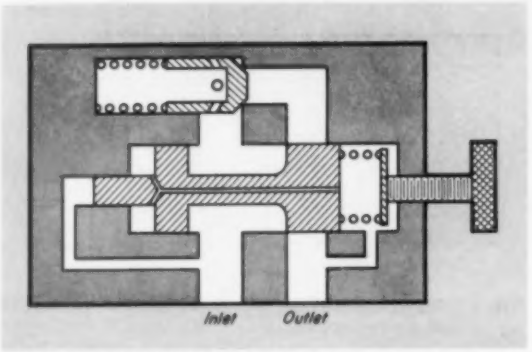


FIG. 14. COUNTERBALANCE VALVE stops flow from its inlet port to its outlet port until pressure at the inlet port overcomes adjusting spring force. An integral check valve permits free flow through the valve in the opposite direction.

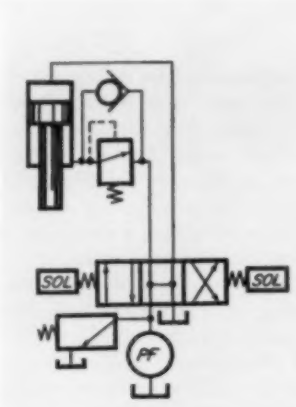


FIG. 15. COUNTERBALANCE VALVE in press circuit holds up piston, platen and die until pressure is applied at the top of the piston. Integral check valve allows flow through the valve to raise the cylinder.

are also made with integral check valves to allow reverse flow, Figure 12.

Valves are also available to sequence flow in either direction through the valve. In these valves, system pressure shifts a small integral shuttle spool which automatically selects sequencing control pressure from the main valve port at the highest pressure.

Control pressure for sequence valves generally is internally ported from the inlet pressure port. However, if sequencing depends on pressure from another part of the circuit, control pressure may be piped externally to the valve.

COUNTERBALANCE VALVES

Counterbalance valves (also called foot valves) maintain a set pressure in part of a circuit, usually to counterbalance a weight or external force. They are often connected to the outlet of press cylinders to support the weight of the piston, platen, and die when the press must remain open. They have built-in check valves which allow free reverse flow through the valve. Flow is shut off at the valve until pressure at its inlet port reaches the valve set on the valve's spring. Fluid then flows through the valve and returns to the system reservoir. Counterbalance valves usually have an internal drain from the spring chamber, Figure 14. They can be internally drained because flow from the valve connects to the system reservoir through the directional control valve.

Control pressure for counterbalance valves may also be externally ported to the valve. It is sometimes taken from the opposite end of the cylinder to prevent counterbalance pressure from opposing the ram and reducing its thrust. If the counterbalance valve is controlled by pressure at the top of the ram, the valve closes the instant flow to the ram stops. To prevent high shock pressures between the ram and the counterbalance valve when the ram stops, this line should be protected with a safety valve. The valve may be adjusted to give the desired deceleration rate at a safe pressure.

If counterbalance valves are set for too high an operating pressure, the system is inefficient. The correct setting is preferably 10% above the pressure setting required to compensate for a load.

UNLOADING VALVES

In many hydraulic systems, pump flow may not be needed during part of the cycle. If pump output has to flow over a relief valve at system pressure, considerable hydraulic energy is wasted as heat. Unloading valves direct pump output to tank at very low pres-

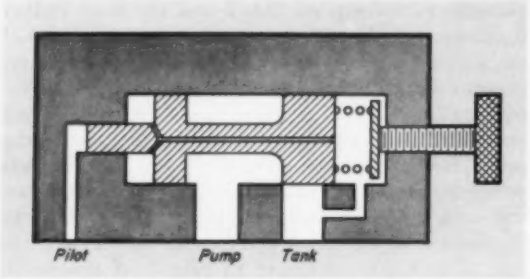


FIG. 16. UNLOADING VALVE is spring-loaded to the closed position. When system pressure, transmitted to the valve through the pilot port, is sufficient to overcome force of the adjusting spring, the valve opens. Pump delivery unloads to the reservoir at low pressure until pilot pressure drops and allows the valve to close. The spring chamber drains to the valve's tank port.

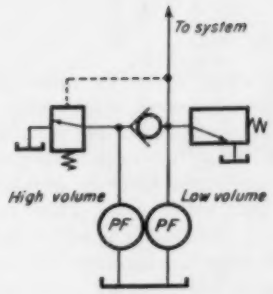


FIG. 17. UNLOADING VALVE in a hi-lo circuit unloads the high volume pump when flow from the low volume pump is sufficient to maintain pressure.

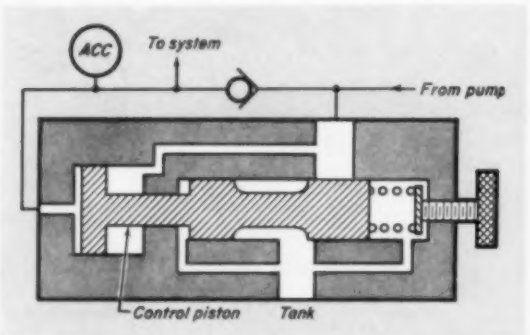


FIG. 18. UNLOADING VALVE for accumulator circuit opens at a set unloading pressure and closes at a lower pressure. The valve opens when the system reaches a pressure determined by the adjustable spring and pump pressure on the right of the control piston. The pump unloads to tank and relieves pressure on the right of the control spool. The valve closes at a lower pressure because force from system pressure on the left of the control spool must only overcome force of the adjusting spring.

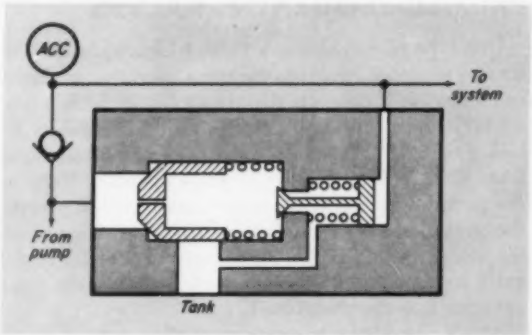


FIG. 19. PILOT UNLOADING VALVE has piston with pump pressure at both ends. The valve is initially held closed by a light spring. When system pressure on the pilot piston overcomes force of the pilot spring the pilot valve opens. Fluid from behind the main valve piston drains to tank, causing a pressure difference across the piston which opens the valve. When system pressure falls, the pilot valve closes, restoring equal pressure to both ends of main valve spool. The light spring closes the valve.

sure after system pressure has been reached. They are installed in the pump outlet line with a tee connection. Discharge from the valve is piped to the reservoir. They are normally-closed, 2-way valves, generally held closed by an adjustable spring at one end of the spool, Figure 16. The spring is opposed by pilot pressure at the other end of the spool. When pressure on the spool exceeds spring force, the valve opens. Hi-lo circuits (Figure 17) which use two pumps for traverse and feed, or clamp requirements, depend on unloading valves to improve efficiency. Output from both pumps is needed only for fast traverse. During feed or clamping, output from the large pump is unloaded to the reservoir at no pressure.

An unloading valve can also be used in an accumulator circuit to unload the pump after the accumulator is charged.

These valves remain open, unloading the pump, while the accumulator supplies pressure fluid to the system. They close when the system uses sufficient fluid to drop accumulator pressure enough to require recharging.

The accumulator unloading valve in Figure 18 is held closed by both spring force and pump pressure acting on the right side of the control piston. When system pressure on the left of the control piston increases enough to overcome spring force and the force due to pressure on the right, the valve opens. The pump unloads and fluid on the right of the control piston drains to the reservoir. To close the valve, system pressure on the left of the control piston must overcome only the force of the adjusting spring. This allows the valve to open at a considerably higher pressure than it closes.

Unloading valves are also made with a pilot to control the main valve, Figure 19. A port through the main valve plunger allows system pressure to act on both ends of the plunger. A light spring plus system pressure acting on the larger area at the spring end of the plunger holds the valve closed. A built-in check valve holds system pressure. When system pressure drops to a preset value, the pilot valve closes. Pump flow through the port in the main valve spool closes the valve.

In most pump unloading valves for accumulator circuits, only the opening pressure is adjustable and the closing pressure is a fixed percentage of it. However, a pilot operated unloading valve may provide adjustment for both pressures. Opening pressure is set by an adjustable pilot valve spring. Pressure difference between opening and closing is set by moving one of two pilot valve seats. Closing pressure may be adjusted from 80% to 95% of opening pressure.

PREFILL-SEQUENCE VALVES

One type of combination valve which includes prefill and sequence functions for press operation is shown in Figure 20. It connects the press cylinder with a prefill tank. When the ram extends, either by gravity or kicker cylinders, the prefill valve opens and fluid flows from the prefill tank into the press cylinder. Varying the press stroke when the press ram meets the work, the prefill valve closes allowing pressure to build up on top of the ram. On the return stroke the prefill valve again opens so fluid flows from the main press cylinder into the prefill tank.

The prefill valve shown in Figure 21, is in its open position. As the press ram is lowered by kicker cylinders, fluid flows from the prefill tank through the prefill valve to the main press cylinder. Pump outlet connects to valve ports 3 & 6 and the head end of the kicker cylinders. Port 4 connects to the rod end of the kicker cylinders. When the press meets the work, pressure builds up at port 6 to the setting of the integral relief valve. The valve opens and pump fluid shifts the prefill valve's spool closing the port to the prefill tank. When the spool shifts, it also connects pump output at port 3 to the main cylinder. When the work stroke is complete, pump output shifts to the rod end of the kicker cylinders to retract the main ram. This applies pressure to port 4 of the prefill valve shifting the control piston to the left and connecting the prefill tank with the main cylinder. Valve opening speed is controlled by an adjustable choke which regulates flow from the left of the control piston. This provides decompression of the press main cylinders. ▼▼▼

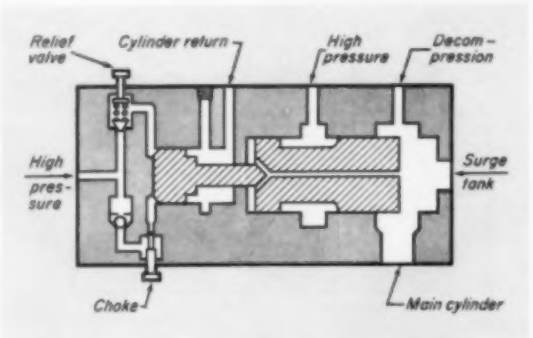


FIG. 20. PREFILL-SEQUENCE VALVE connects the prefill tank to the main press cylinder during rapid advance and return. It permits a large volume of fluid to flow into the press cylinder when it extends, and from the cylinder into the prefill tank when the cylinder retracts. The valve connects pump output to the cylinder during the work stroke. The valve illustrated includes, sequence, check, and needle valve in the pilot system.

Courtesy The Oilgear Co.

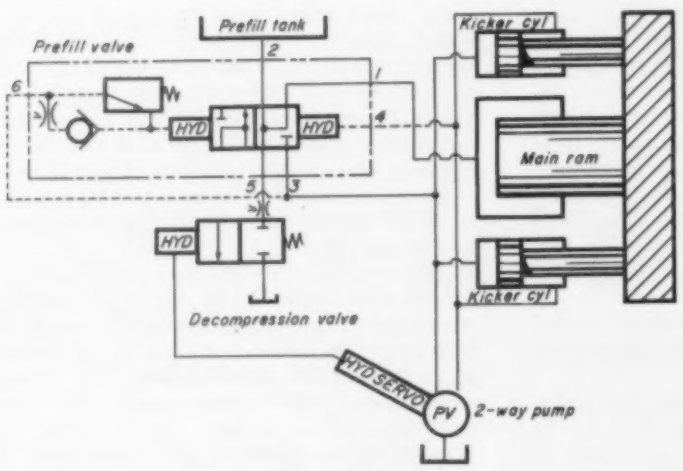
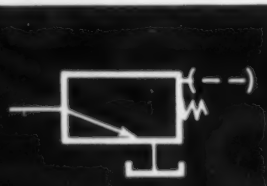
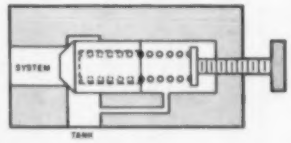
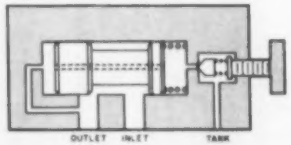
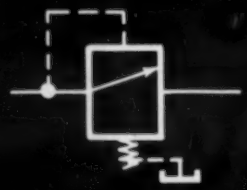
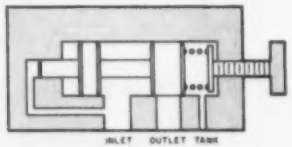
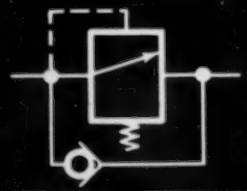
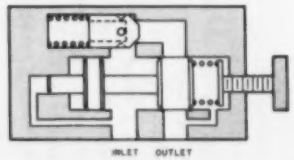
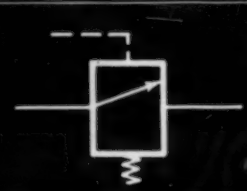
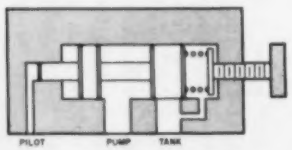


FIG. 21. PREFILL CIRCUIT is used on large presses to fill the main cylinder by gravity during approach stroke. The valve connects a prefill tank to the main cylinder during rapid advance and retraction. When the ram meets the work, pressure at the valve's high pressure, pilot port increases to the setting of the pilot relief valve. Fluid then flows into the chamber on the left of the control piston, shifting the spool right and closing the valve. Pressure for retracting the ram is applied to the right of the valve's control piston, holding the prefill valve open.

HYDRAULIC PRESSURE CONTROL VALVES

RELIEF			Limits pump output pressure. Regulates system pressure. Bypasses a filter to prevent pressure damage to element. Serves as a pilot valve to vent main system relief valve. Used as a safety valve to relieve shock pressures.
PRESSURE REDUCING			Allows one branch of a circuit to operate at a lower pressure than main system. Protects components with lower operating pressure ratings. Permits accurate control of cylinder force.
SEQUENCE			Prevents fluid from entering one branch of a circuit until a set pressure is reached in the main circuit. Extends and retracts cylinders in sequence. Used in clamping circuits to assure pressure to the clamps before work cylinder extends.
COUNTERBALANCE			Holds pressure in part of a circuit to counterbalance weight on external force. Used on down-acting presses to hold up ram. On missile erection equipment, it counterbalances negative forces as erector moves over center.
UNLOADING			Unloads pump delivery to tank at low pressure when not required. Used in accumulator circuits so pump delivers fluid at pressure only when charging accumulator. In a hi-lo circuit, it unloads the high volume pump while the low volume pump supplies the system.

Electrohydraulic Analogies ...systems approach to fluid power - 2

• By **ROBERT E. RAYMOND,** *The R. E. Raymond Co., Zanesville, Ohio*

DEVELOPMENT OF DYNAMIC CIRCUIT ELEMENTS

FLUID power systems convert energy from one form to another for fine control and useful work. In electrical systems, we must convert mechanical energy into electrical form, handle this energy electrically, and convert again to mechanical form for useful work. So it is with fluid power. Pumps are mechanical-to-hydraulic converters; valves are hydraulic-to-hydraulic converters; and cylinders and fluid motors are hydraulic-to-mechanical converters. The fundamental phases of circuit operation during energy transfer are:

a. Input phase
b. Internal control phase
c. Output phase.

Fig. 1 shows the hydraulic and electrical components used in each phase.

• **Generator—Motor Analogy**—Fixed displacement pumps deliver flow proportional to speed and displacement,

$$Q = V_d N \quad (1)$$

where: V_d = pump displacement

D-C electrical generators produce voltage proportional to speed and field strength.

$$E = C_1 \phi N \quad (2)$$

where: ϕ = field flux
C_1 = machine constant

Pump displacement is then analogous to field strength and associate parameters of electrical generators.

Flow frequency of a piston pump is a function of speed and the number of pumping elements. Frequency

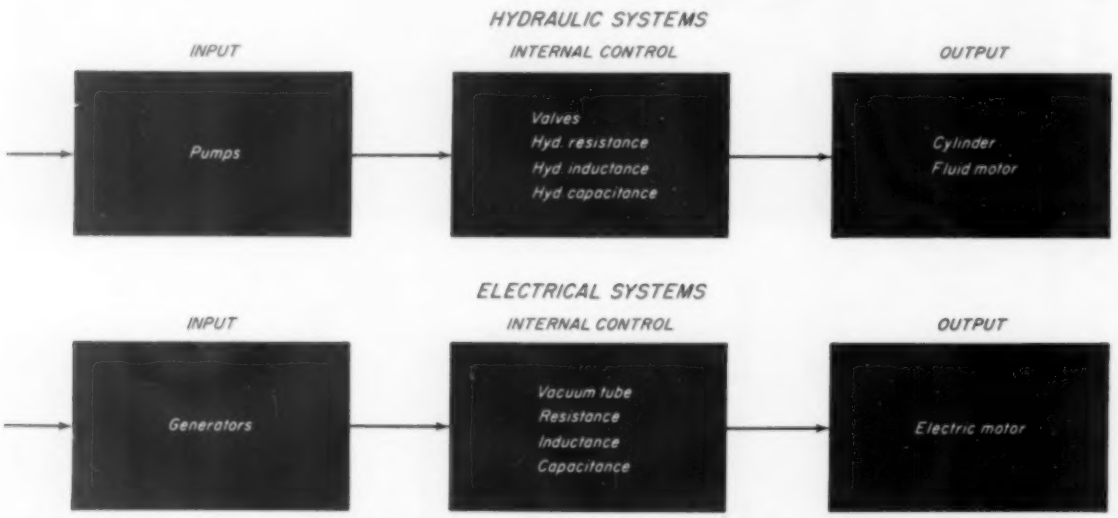


FIG. 1. HYDRAULIC AND ELECTRICAL SYSTEMS can be divided into three operating phases according to energy transfer.

of voltage in a generator is a function of speed and the number of poles. Generator poles are then analogous to pump pistons, vanes, or gears.

Fixed displacement pump operation is analogous to a constant current electrical system. In contrast, a pressure-compensated, variable displacement pump maintains constant pressure and delivers flow on demand. It operates analogous to an electrical generator at constant voltage.

With a variable displacement pump, the set pressure drops as flow increases because of finite compensator regulation and other internal reactions. Generator voltage also drops when current is delivered to a load, because of internal armature resistance, brush resistance and armature reaction.

Constant pressure and constant flow systems are shown in Fig. 2. As an example, if a weight-loaded

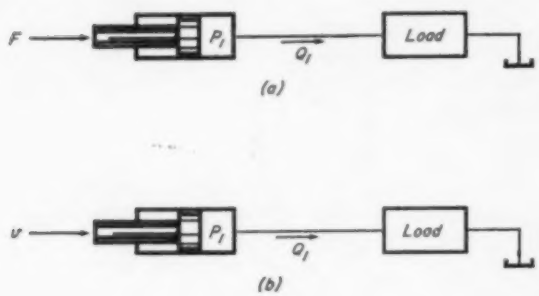


FIG. 2. CONSTANT PRESSURE (a) AND CONSTANT FLOW (b) SYSTEMS. For constant force input in (a) pressure is constant. Flow varies with load impedance. This is analogous to electrical constant voltage system. For constant velocity input in (b) flow is constant and pressure varies with load impedance. This is analogous to an electrical constant current system.

accumulator were used as a source of fluid power, replacing a rotary pump, the system input would be at constant pressure. Short circuit conditions would induce very high flows and flow interruptions would cause high pressure peaks because of large inductive effect of the accumulator's mass.

With d-c electric motors, torque is proportional to armature current and field strength,

$$T = K_t i \tag{3}$$

where: K_t = motor field constant

Hydraulic motors develop torque as a function of pressure and displacement.

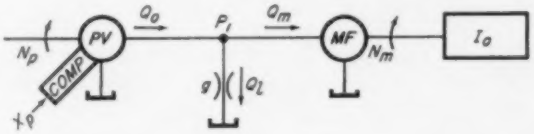
$$T = \frac{P V_d}{2\pi} \tag{4}$$

where: V_d = pump displacement

Many combinations of pump and motor controls correspond to field controls of d-c motors and generators. If the field strength of a d-c motor is reduced, the motor speeds up but its torque capability is reduced. Similarly, if the displacement of a variable fluid motor is reduced, the motor speeds up and the torque capability is reduced. These are direct analogies of response.

Details of motor-generator design can also be compared to hydraulic problems, increasing the feel for system equivalence. In electric motor design characteristics of flux leakage, resistance drop, and counter E.M.F. are largely determined empirically for proper component design. The same is true for fluid leakage paths, friction sources and pressure loading effects in pump-motor design.

• **System Equations**—To use the available background of systems analysis effectively, we must be able to express fluid power relationships mathematically. First we must develop equations. This is done by summing flow rates at nodes or junctions of flow paths



I_o = Load inertia
N_m = Motor speed
T_m = Motor torque
Q_m = Motor flow
V_{dm} = Motor displacement
N_p = Pump speed
Q_o = Pump output flow
V_{dp} = Pump displacement
V_{xp} = Pump displacement / stroke
X_p = Pump displacement stroke
g = Pump - motor lumped conductance

FIG. 3. ELEMENTARY PUMP-MOTOR TRANSMISSION driving inertia load. Pump and motor leakage is lumped in conductance g.

or equating forces on free bodies.

An elementary hydraulic transmission is shown in Fig. 3. With the pump running at constant speed, load speed is regulated by adjusting pump stroke. Transmission line resistance and capacitance are assumed negligible because of short lines. Leakage of pump and motor is lumped in conductance g. Parasitic effects in pumps and motors are omitted for simplicity in this analysis.

Mechanical torque output is:

$$T_m = 2\pi I_o \frac{dN_m}{dt} \tag{5}$$

where: I_o = Load Inertia
N_m = Motor Speed
T_m = Motor torque

Converting to pressure and flow terms:

$$\frac{V_{dm} P_l}{2\pi} = \frac{2\pi I_o}{V_{dm}} \frac{dQ_m}{dt} \tag{6}$$

where: Q_m = Motor Flow
V_{dm} = Motor Displacement

In flow form this is:

$$Q_m = \frac{V^2_{dm}}{4\pi^2 I_o}\int P_1\,dt = \frac{1}{L_h}\int P_1\,dt \qquad (7)$$

where L_h = Hydraulic inductance

System equations are developed as follows:

$$Q_o - Q_m - Q_l = 0 \text{ (Flow node)} \qquad (8)$$

$$Q_l = g\,P_1 \text{ (Pump-motor slip flow)} \qquad (9)$$

Substituting equations (1) (7) and (9) into equation (8), we have:

$$V_{dp}\,N_p - \frac{V^2_{dm}}{4\pi^2 I_o}\int P_1\,dt - g\,P_1 = 0 \qquad (10)$$

which is in differential flow form,

The term $4\pi^2 I_o/V_{dm}^2$ is the inductance effect L_h of the lead inertia. It indicates the important influence of motor displacement on inductance.

From Table 1 in Part 1, we can convert the differential form to frequency form to obtain a more comprehensive expression:

$$V_{xp}\,X_p\,N_p = \left[\frac{1}{j\omega L_h} + g\right] P_1 \qquad (11)$$

$$V_{xp}\,X_p\,N_p = \left[\frac{1 + j\omega L_h g}{j\omega L_h}\right] P_1 \qquad (12)$$

$$P_1/X_p = V_{xp}\,N_p\,L_h\,\frac{(j\omega)}{1 + L_h g(j\omega)} \qquad (13)$$

Equation (13) is commonly known as the system transfer function. It expresses the relation between P_1 and X_p as a function of frequency and system perameters. Replacing $(j\omega)$ by S, puts the expression in Laplace operator form:

$$\frac{P_1}{X_p} = V_x\,N_p\,L_h\,\frac{S}{1 + L_h g S} \qquad (14)$$

Studying this expression by standard methods including graphical plots enables the designer to analyze system performance both qualitatively and quantitatively. He can determine frequency response, pressure overshoot, stability, and accuracy by these methods. Part 3 will develop a particular problem in detail.

• **Valves as Switches**—A hydraulic valve is essentially a switch. It is either on or off. When a valve modulates flow, it produces a variable resistance and is comparable to a vacuum tube.

When electrical switches are opened there is a sudden interruption of current depending on switch geometry and switching speed. In a highly inductive electrical circuit, inductance creates a voltage which opposes the interruption of current. A high voltage builds up across a switch that opens fast. This voltage tends to force current flow to continue and causes arcing at the switch contacts as they open.

Similarly, in fluid power, when a valve closes fast, pressure builds up in proportion to hydraulic inductance and the rate of flow change (rate of valve closing).

$$P = L_h\,\frac{dQ}{dt} \text{ (Pressure Rise)} \qquad (15)$$

Water hammer and shock waves caused by closing valves are explained by these simple fundamentals.

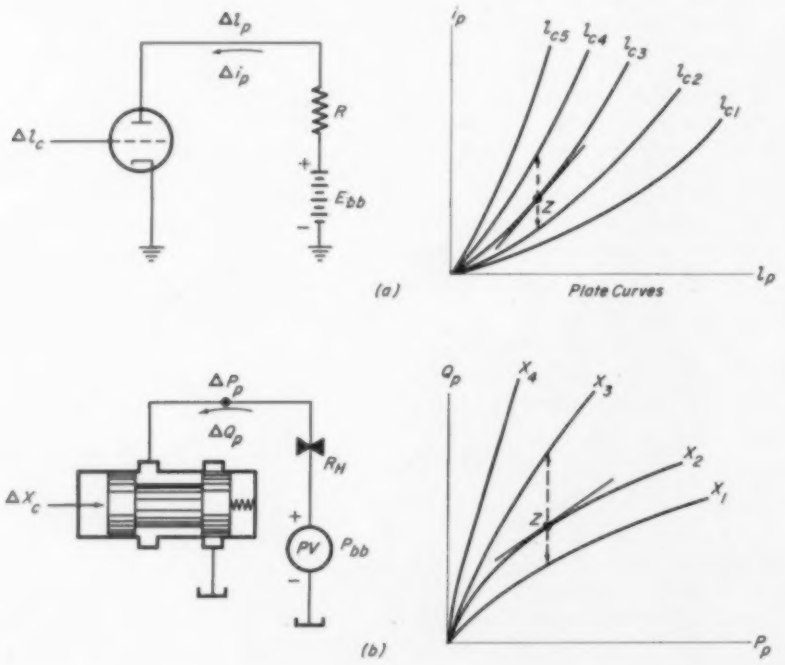
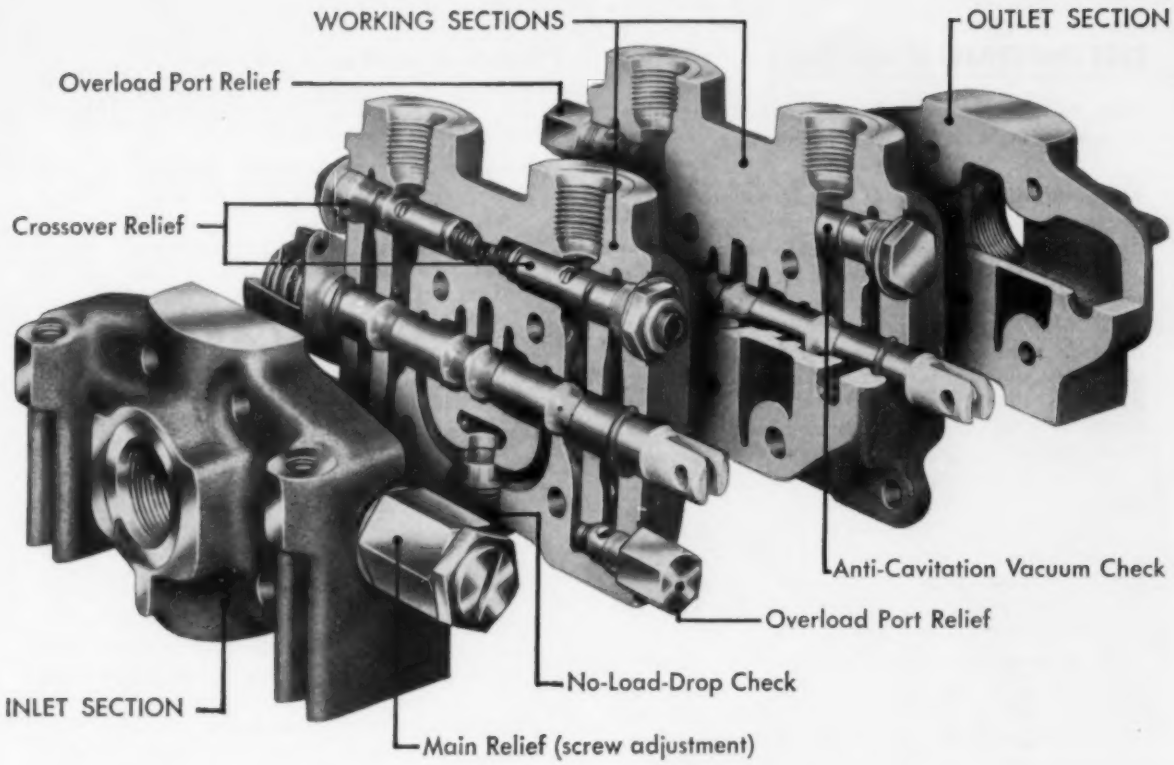


FIG. 4. ANALOGOUS CHARACTERISTICS of triode vacuum tube and pilot operated, 2-way valve. D-C operating point is at Z.



Only 12 psi drop in new 2000 psi valve

For earth moving, mining, materials handling, agriculture and ground support equipment

COMMERCIAL Model A, series 20 and 35 manually operated parallel circuit valves directionally control fluid power up to 2000 psi. Internal pressure drop has been reduced at least 50% compared to earlier models. Back pressure in the exploded A20 valve, illustrated, having two working sections, is only 12 psi at 20 gpm through flow—all spools neutral. Under same conditions, valve having six working sections records back pressure of only 33 psi. Performance of the A35 valve is equally outstanding. Complete, all-condition performance ratings are available—proving quite revealing.

Exclusive Easy Access Features

- MAIN RELIEF VALVE controls system relief pressure—circuit loaded
- NO-LOAD-DROP CHECK blocks pressurized return flow
- FLOW RESISTOR CHECK controls rate of cylinder movement
- OVERLOAD PORT RELIEF prevents pressure build-up beyond port—spool neutral
- ANTI-CAVITATION VACUUM CHECK releases vacuum build-up in cylinder
- CROSSOVER RELIEF protects against shock load—spool neutral

Smooth, Precise Operation—COMMERCIAL's new, rugged, heavy-duty valves eliminate jerky, erratic movements of equipment common to ordinary valving. Highly sensitive and positive is their action. Just "velvet touch", finger tip, spool operation meters the most precise and delicate flow. Feel of equipment motion actually "plays back" through the spool handle.

Control Functions for All Needs—Working sections can be assembled in tandem, in any sequence. Sections with 3 or 4 spool positions are available with spring return or detented spool actions. Single acting, double acting, hold or float actions are all available. Complete hydraulic system and equipment protection can be yours—built right into Model A valves—without external piping.

Technical Service and Literature—Experienced technical service and assistance is available from our factory-based personnel. Bulletin 100-P16 gives full data on the new Model A valves. Address: Commercial Shearing & Stamping Company, Dept. A-13, Youngstown 1, Ohio.

pumps, valves, cylinders, motors

COMMERCIAL *shearing & stamping*

Circle **32** on Reader Service Card

Often the most serious inductive effect is caused by an external mass rather than fluid inertia or velocity.

• **Valve-Tube Physics**—Development of the vacuum tube emphasized the problem of treating non-linear elements in electronic systems. Graphical analysis was perfected. Variables were treated as linear within a range about a d-c operating point.

Fig. 4(a) illustrates the basis of tube physics. Current through a vacuum tube is a function of both plate voltage and grid voltage. These functions are not linear over a complete range. An experimental family of plate curves for a tube dsecribes these effects. No matter what slope the curves have, the situation can be treated as linear within a limited range.

Transconductance and plate conductance are slopes of tube curves at a point. They vary with the operating point and tube parameters. However, these figures of merit describe the incremental, variable performance of the tube within a range.

A (Δ) prefix on variables means a small increment of the quiescent variable. This small change is the prime variable for standard, linear mathematical analysis. In frequency studies, the increment is considered the a-c variable; the d-c part is ignored. For tubes, the d-c operating point determines tube transconductance and plate conductance for a-c operation.

The tube equation is:

$$\Delta i_p = \left[\frac{\partial i_p}{\partial e_c}\right] \Delta e_c + \left[\frac{\partial i_p}{\partial e_p}\right] \Delta e_p \qquad (16)$$

where: e_c = grid voltage
e_p = plate voltage
i_p = plate current

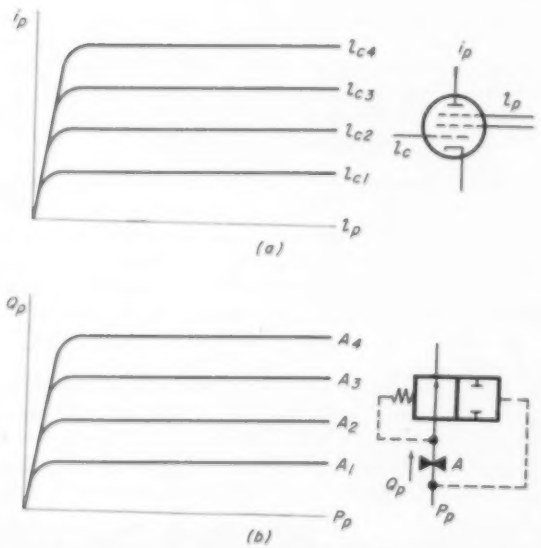


FIG. 5. PENTODE TUBE AND PRESSURE COMPENSATED FLOW CONTROL have analogous characteristics.

Tube gain or amplification factor is:

$$\mu = \frac{\Delta e_p}{\Delta e_c} = \frac{g_m}{g_p} \qquad (17)$$

where: g_m = tube transconductance (e_p = constant)
g_p = plate conductance (e_c = constant)

Analogous valve characteristics are

$$\Delta Q_p = \left[\frac{\partial Q_p}{\partial X_c}\right] \Delta X_c + \left[\frac{\partial Q_p}{\partial P_p}\right] \Delta P_p \qquad (18)$$

where: Q_p = flow through valve
P_p = pressure at valve
X_c = valve spool displacement

Valve gain or amplification factor is:

$$\mu = \frac{\Delta P_p}{\Delta X_c} = \frac{g_{mh}}{g_{ph}} \qquad (19)$$

where: g_{mh} = valve transconductance (P_p = constant)
g_{ph} = valve plate conductance (X_c = constant)

Fig. 4(b) describes the exact analogy for a hydraulic valve. *Valve transconductance* and *valve plate conductance* are used later as parameters in transfer function analysis.

The term ΔX_c is shown analogous to grid voltage. Actually, we could have applied a control pressure ΔP_c to the spool end for a more comparable expression. However, it is better to assume X_c as the basic grid relation because bias spring design can change ΔP_c from one case to another. ΔX_c is inherent in a particular valve.

Valve increment equations are derived from conventional formulas as follows:

$$Q = 100\pi\, DX\sqrt{P} \text{ in.3/sec (Valve Orifice Law-Recessed Ports)} \qquad (20)$$

The partial derivative of Q with respect to X is:

$$\frac{\partial Q}{\partial X} = 100\pi\, D\sqrt{P_s} = g_m \text{ (Z is operating point)} \qquad (21)$$

The partial derivative of Q with respect to P is:

$$\frac{\partial Q}{\partial P} = \frac{100\pi\, DX_s}{2\sqrt{P_s}} = g_p \text{ (Z is operating point)} \qquad (22)$$

Total valve incremental flow is then:

$$\Delta Q = \frac{\partial Q}{\partial X}\Delta X + \frac{\partial Q}{\partial P}\Delta P \qquad (23)$$

Values of g_m and g_p depend on both operating point and valve geometry. Later circuit analysis in this series will show how these parameters effect gain and phase in feedback.

When valve spools are slotted or tapered, what has happened from a mathematical and physics point of view is that we are shaping g_m and g_p. If we knew what g_m and/or g_p were required for a control situation, we could specify the type of mechanical situation required at the spool throttling lands.

Continued on page 88

Your local Gates Fieldman can give you valuable technical aid for hydraulic hose applications

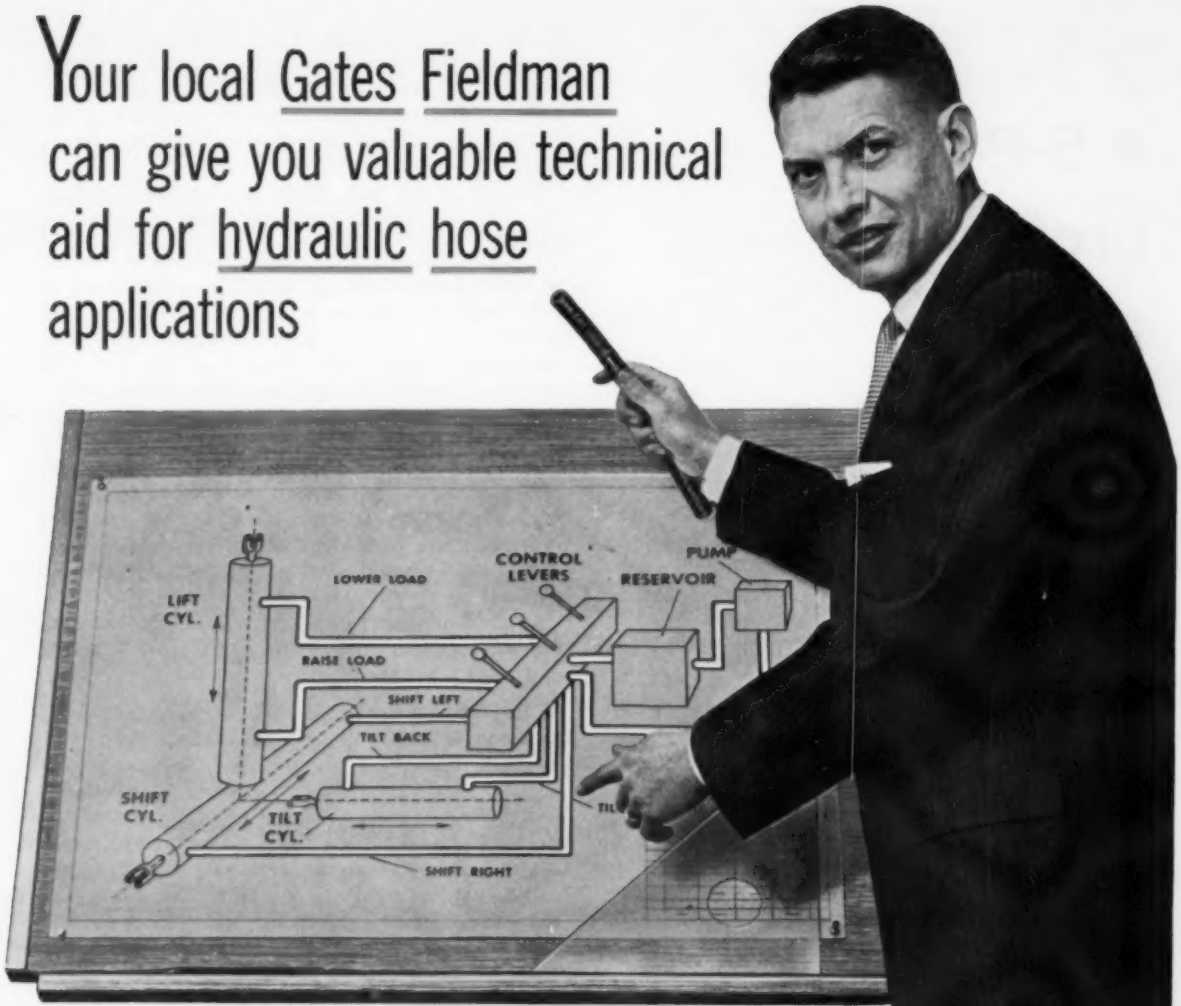


Diagram of hydraulic system in Blackwelder Fork Lifts for every farm material-handling operation. White lines indicate Gates Hose for hydraulic fluid operating lift, tilt and shift cylinders.

The Gates Fieldman located near you is a highly-qualified hydraulic hose expert. He can share with you the accumulated design experience gained by Gates from years of working with leading manufacturers of hydraulically operated equipment. He will be glad to work closely with you through all stages of design, development and manufacturing to assure top performance of your hydraulic systems.

In designing a hydraulic system, selection of the proper hydraulic hose for the job is an important consideration. Gates Hydraulic Hose is constructed to meet or exceed SAE specifications. It is a top-quality product of Gates continuing program of *Specialized* Research.

Gates Hydraulic Hose is quickly available nation-wide in bulk lengths and coupled assemblies of wire-braided and cord-braided construction. It comes in a complete range of types and sizes for medium-pressure and high-pressure applications.

Contact your nearby Gates Fieldman for expert hydraulic design aid. Ask him for Gates Hydraulic Hose Assemblies booklet, IH43.

The Gates Rubber Company, Denver, Colorado BP-38

Gates Hydraulic Hose is quickly available anywhere from nearby stocks.
Building the future on 50 years of progress
Gates

Gates Hydraulic Hose

A 5-Point program for air valve maintenance

• By EDMOND C. POWERS
Educational Director,
Compressed Air and Gas Institute, Cleveland, Ohio

AIR VALVE failure can often shut down an entire production line. Though modern, plug-in, subplate-mounted valves are designed for quick replacement, with proper care and maintenance much can be done to increase valve life.

Here are five important ways to increase air valve dependability.

1. **Maintain an adequate supply of clean, dry air.**
2. **Inspect valves at regular intervals and record inspection results.**
3. **Make on-the-spot replacements and repairs at the time of inspection.**
4. **Select valves carefully—consider size, material, operating temperature, type, and pressure range.**
5. **Install valves properly—including tagging, seating, packing and seals, and connections to air supply.**

• **Air Supply**—Valve care begins at the compressor and must continue through the entire pipe layout. Compressor suction filters should be clean and located where they draw in clean, dry air. Poor gaskets and seals allow dirt to enter the compressor or air to leak out.

Worn piston rings on reciprocating compressors permit oil and dirt from the crankcase to get into the air system.

The aftercooler may be another source of contamination. When compressed air cools, water condenses out. If this water is not trapped and taken out of the air stream, it will pass through the air lines to valves and other equipment downstream. The aftercooler with moisture separator should be installed in the compressor discharge line ahead of the air storage tank.

The air storage tank should also have an automatic drain trap to remove moisture which condenses in the tank.

• **Valve Inspection**—A thorough inspection of all valves should be made at regular intervals, and inspection records should be kept. Check lists indicating the manufacturer's recommendations for servicing should be used to prepare inspection records.

A typical inspection record lists valve location, manufacturer, size, type, function, rating, and specific items to be checked. The record should also include results of the inspection, such as: *OK*, 4-1-61 or *seat replaced*, 4-1-61. The record serves as a guide for ordering spare parts, so that normal wearing parts are on hand when needed, and unnecessary parts are not ordered.

Inspections should include checking air connections for tightness, and condition of packing, seals, gaskets, diaphragms, and springs.

• **Repair and Replacement**—Minor repairs should be made, and worn parts replaced at the time of inspection. Repairs made at this time, before harm has been done, will pay for themselves in preventing breakdowns.

Valves should be thoroughly cleaned, and worn or cracked seals and gaskets replaced. Leaking poppet valves may be repaired by lapping the seat with a fine valve grinding compound.

If worn valves are replaced with valves having different characteristics, or manufacturer's maintenance recommendations are changed, suitable changes should be made in the maintenance inspection records.

When new packing is installed, be sure it is the correct kind and grade. If a lubricator is used in the line, be sure the packing is compatible with oil.

• **Valve Selection**—If an air valve has given satisfactory service life, it is natural to replace it with a similar valve. However, it may not always be possible, because manufacturers modernize their designs. Sizing the valve is important. An oversized valve may be sluggish, and an undersized valve will not allow adequate air flow. In replacing valves, the temperature and pressure ranges must be comparable to those of the old valve. Exceeding manufacturer's pressure or temperature recommendations is unsafe.

• **Installation**—New valves should be installed in the position recommended by the manufacturer. Some are intended only for vertical mounting and others for horizontal. Be sure flow is in the proper direction through the valve. Some valves have arrows indicating proper flow direction.

Before bolting or threading a valve to an air line, be sure that the piping is lined up properly. This prevents stressing the valve body. ▼▼▼

Circle 115 →

Announcing a brand-new Sundstrand pump for hundreds of hydraulic applications

. . . from operation of dental and beauty chairs to lube oil pumping

This new Model G pump is a small, compact, high-quality unit, designed to be either bracket- or motor-end-bell-mounted. It is produced in five sizes, with capacities ranging from 12 to 40 gph (at 1725 rpm, 0 psi), depending on pump size.

Maximum pressure is 600 psig. Minimum and maximum speeds are 600 and 3400 rpm. Standard features include a mirror-lapped face seal (far superior to ordinary seals) . . . an adjustable poppet-type relief valve with extra-long guide stem that eliminates pulsations . . . quiet, hydraulically balanced Rota-Roll gears . . . long shaft bearing . . . available with internal recirculating bypass or optional return port.

Genuine parts and expert service are available at Sundstrand Service Stations throughout the country. If you think you have an application for this new pump, write today for literature and full details on prices and delivery.

AVIATION & DEFENSE SUNDSTRAND

MACHINE TOOLS SUNDSTRAND

PACKAGING MACHINERY SUNDSTRAND

INDUSTRIAL EQUIPMENT SUNDSTRAND

INTERNATIONAL SUNDSTRAND

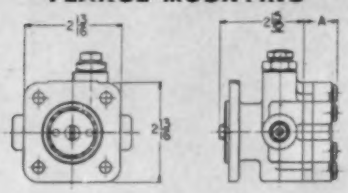
SUNDSTRAND HYDRAULICS

DIVISION OF SUNDSTRAND CORPORATION

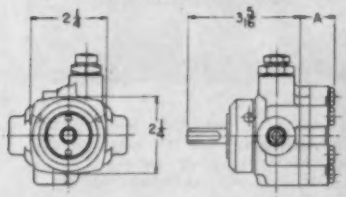
2210 Harrison Avenue, Rockford, Illinois
Eastern Sales Office: 89 Summit Avenue, Summit, New Jersey

HYDRAULICS SUNDSTRAND

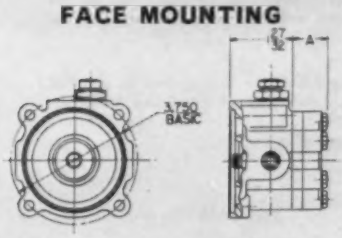
FLANGE MOUNTING

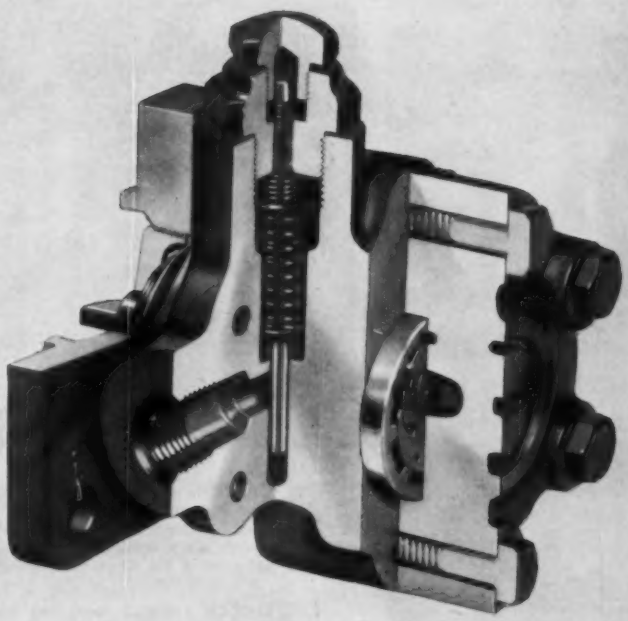


HUB MOUNTING

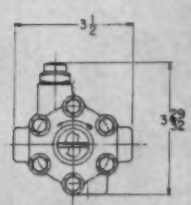


FACE MOUNTING





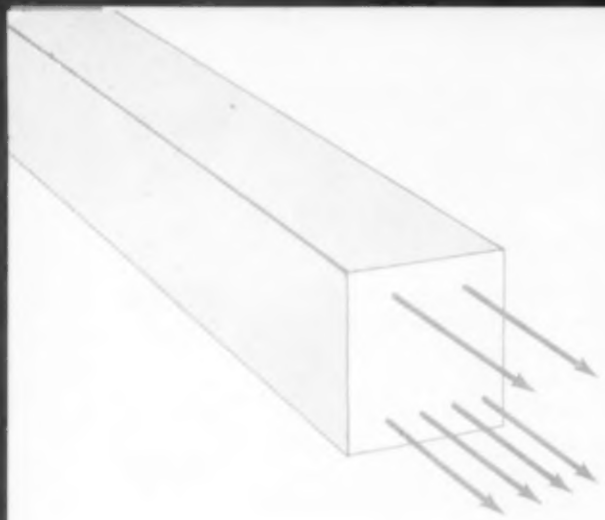
MODEL G



Model No.	Gear Width	"A" Dimension	Delivery at 1725 RPM OPSI	HP Req'd at 1725 RPM			
				40 PSI	80 PSI	200 PSI	600 PSI
G1	.180	15/16	12	.05	.06	.09	.22
G3	.280	1-1/32	20	.07	.08	.11	.26
G4	.340	1-3/32	24	.08	.10	.14	.32
G5	.437	1-3/16	31	.10	.12	.17	.40
G6	.562	1-5/16	40	.12	.14	.21	.53

Single strand tensioning

● By **JAMES S. SIMMS**, *President, Simms Engineering Company,*

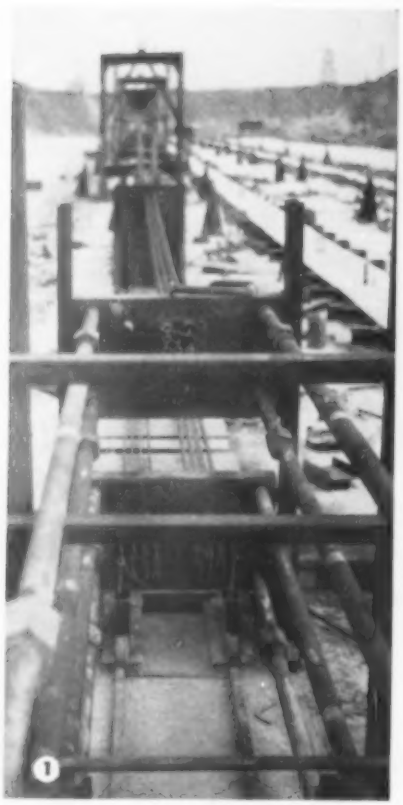


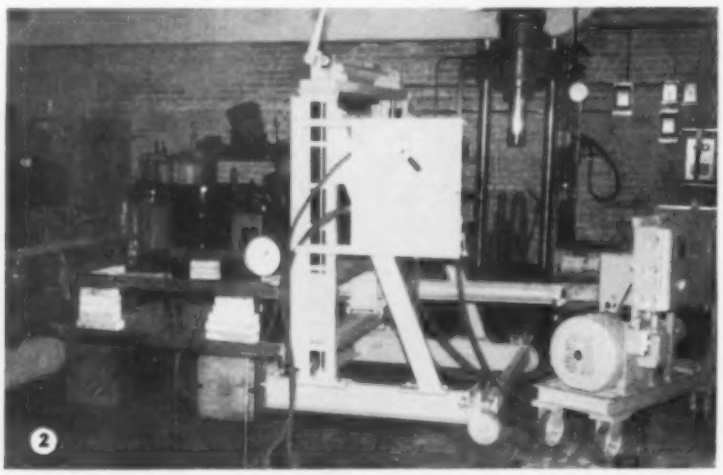
This new method stresses steel strands one at a time, yet is twice as fast as the multistrand method which stresses 20 or more at a time. It simplifies the hydraulic circuit and components, eliminates heavy structure, and is safer.

IF YOU remember your strength of materials, you recall that concrete has very high strength in compression but low strength in tension. To improve its tensile strength, steel rods or strands under tension are cast into a concrete beam. These prestress the beam after it has hardened.

A common way of tensioning the steel strands is to use four cylinders: two for the upper strands and two for the lower strands. These cylinders are supplied by an 8-piston pump manifolded so that two pistons discharge into each cylinder. Each piston should deliver the same amount of oil, so that the cylinders move together. Pressure differences, however, cause a difference in slip and delivery in each piston.

● **Compression and Tension In Beam**—In a usual structure the top of a concrete beam is normally in compression and the bottom is in tension. In prestressing the beams, more steel strands are cast into the bottom than the top. Therefore force requirement





1 **CASTING BEDS** are 600 ft long and laid out in pairs back to back to keep the tensioning equipment in a central area. Each set (upper and lower) of tensioning rods is attached to its template carriage. The strands are anchored in the templates. Carriages and tensioning rods are not used in the single strand method.

2 **SINGLE STRAND** tensioning equipment is simpler in construction and much less expensive. The control panel is mounted on the frame so the operator is close to the tensioning area and has more accurate control of the operation.

3 **TENSIONING FRAME** is moved easily from one casting bed to another. The frame is not moved after being positioned at a casting bed. The cylinder is shifted instead. It is mounted on a roller carriage for horizontal movement, and a hand crank moves it vertically.

eliminates pump slip effect

Chicago, Illinois

on the bottom tensioning cylinders is greater and requires greater pressure, since all four tensioning cylinders are the same size.

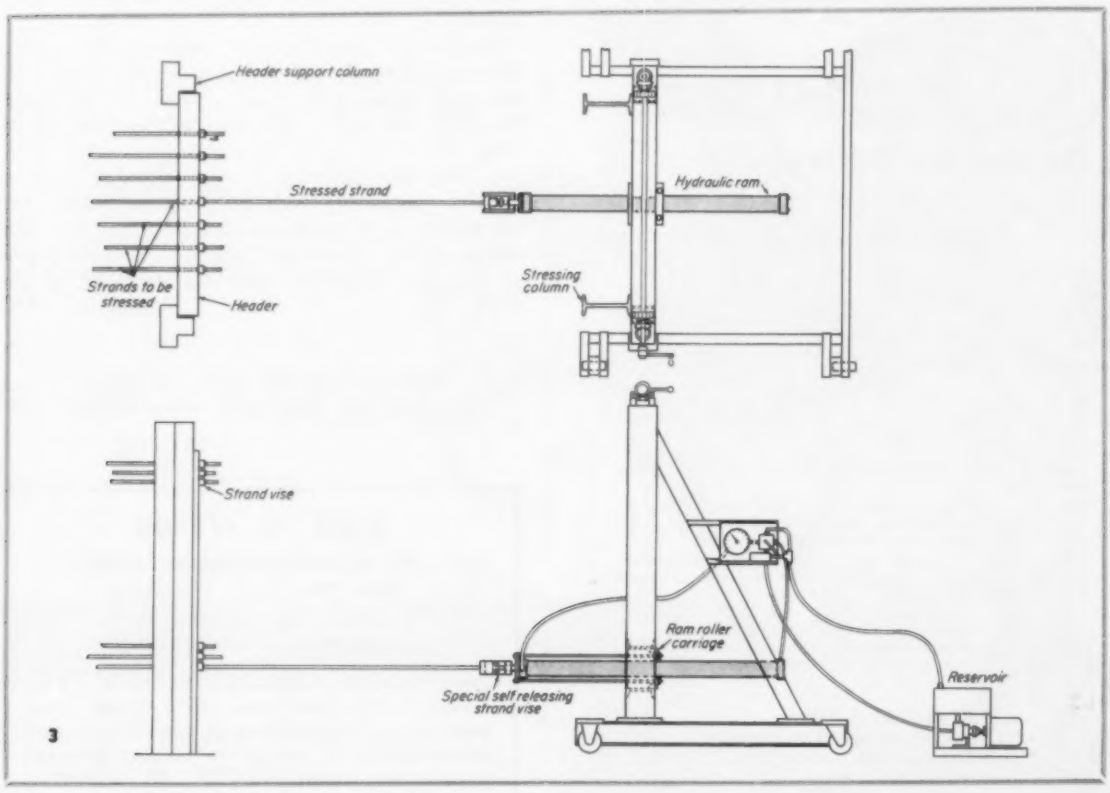
This difference in pressure causes a difference in pump piston slip and delivery. In jacking out the rams, the top two extend faster than the bottom two, so that the operation must be stopped and the cylinder extensions measured and equalized before continuing. Not only is this time-consuming, but the unequal cylinder extensions put undue strain on the tensioning rods which sometime break.

• **Single Strand Method**—Simms Engineering Co. has developed single cylinder tensioning equipment to tension one strand at a time. The method is much simpler, so that the time to tension the strands of a beam is cut in half. Also the tensioning equipment costs 60% less, and there are savings in simpler casting bed construction.

Strands are tensioned one at a time to the desired tension in one operation. They do not require initial tensioning as in the multistrand method. With the single cylinder the operator knows immediately if the strand is properly tensioned and anchored before he tensions the next strand. This reduces injury due to a faulty strand vise. Each strand is tensioned to 100% of design stress—not over or under as in the multistrand method.

• **Difficult to Move**—The tensioning equipment used in the multistrand method is very heavy and cumbersome. It is moved with great difficulty from one casting bed to another. The single cylinder has a simple, light frame, mounted on casters, for easy positioning from one bed to another. The cylinder is mounted on rollers for horizontal movement from one strand to another at a casting bed. A hand crank moves the cylinder vertically.

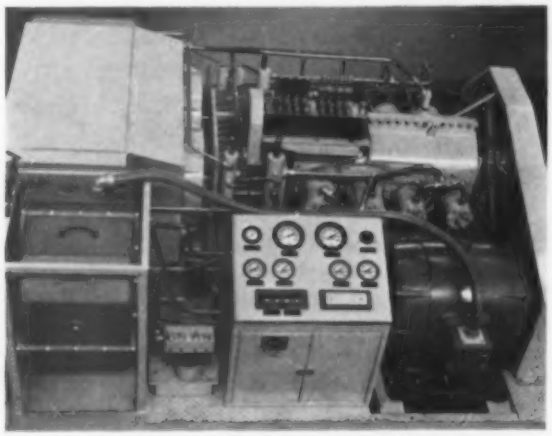
The 7-piston hydraulic pump is directly coupled to the motor, whereas the multistrand pump is chain-driven by a geared-down motor. ▼▼▼



When You Need

HIGH PRESSURE HIGH CAPACITY, HIGH PURITY AIR, HELIUM NITROGEN

FOR COMPONENTS TESTING OR PRODUCTION



MODEL DPB-CCS Four-stage, 8-cylinder compressor. System includes full dehydration and oil removal, filter and complete control panel. Backed by Cardair's 20 years of high pressure gas experience. The only ICBM type compressor qualified by 2500 hour life test.

CCC CARDAIR CENTRAL COMPRESSION SYSTEMS

Guarantee Delivery

- up to 12,000 psi continuous
- with less than 1 ppm oil content
- 150 SCFM @ 128 psig intake • dewpoint −100°F.

Developed and qualified as GSE equipment for ICBM program—now available from stock or programmed production!

Most recent broad purpose Central Compression System in the Cardair line, the Model DPB-CCS is a semi-portable, skid mounted unit, ready to install on location in less than a day. Only electrical and high and low pressure connections are needed.

In addition to air, helium and nitrogen, it can be easily adapted to other gases including hydrocarbons and hydrogen. Pressure range is from 3500 to 12,000 psi in continuous service and to 15,000 psi intermittently. Complete dehydration and oil removal equipment are included.

For either testing or production, it may also be used as a central high pressure source for diverse locations, with Cardair supplying the complete system.

Maintenance is simple and minimal, with nationwide Cardair service facilities. Installation is easy—no heavy concrete base is required.

Write today for illustration sheet and technical data—or send us information on your particular high pressure supply needs.

CARDAIR

DIVISION OF MARMON-HERRINGTON COMPANY, INC.
Dept. 14, Box 147—Lebanon, Indiana

Western States Distributor:
General Air Equipment
824 Hollywood Way, Burbank, Cal.

Circle **24** on Reader Service Card

ELECTROHYDRAULIC ANALOGIES

Continued from page 82

This is precisely the procedure in choosing tubes for an electronic circuit. The considerations are power, frequency response, d-c operating levels, g_m and g_p values and other factors.

This remarkable analogy between valve and tube can be carried further in the relationship between a pentode tube and pressure-compensated flow control valve. Figure 5(a) shows plate curves for a pentode tube. These flat curves show high plate resistance (low g_p) produced by auxiliary grids. The pentode has much lower g_p than a triode. Consequently it has a higher amplification factor:

$$\mu = \frac{g_m}{g_p} \qquad (24)$$

Characteristic curves of a pressure-compensated control valve are shown in Figure 5(b). The grid adjustment is at the control orfiice, and the compensator spool causes a very high internal resistance to flow changes caused by pressure changes. This is precisely the action of a pentode grid in an electronic system. Spool inertia, viscous friction, spring rates, leakage, and jet force reactions are handled as effects encountered in the grid circuit of the valve.

• **Mathematics with Judgement**—All elements of a hydraulic circuit must have representative mathematical expressions which reasonably describe their performance within a region. The amount of detail is a matter of judgement. Many times preliminary studies require only simplified expressions to be very valuable.

Quite often, details merely complicate the mathematical expressions and do not contribute to the performance anlysis significantly. When extreme nonlinearities are encountered they can be handled by computers.

A fast, comprehensive system approach requires complete familiarity with the basic principles, and the ability to set up simplified expressions of system effects with experience and judgement as to the degree of linearity, complexity, and importance of all elements. ▼▼▼

Part 3 of this series will introduce transfer function methods through a specific closed loop control example. Practical system analysis will be developed.

PLAN TO ATTEND

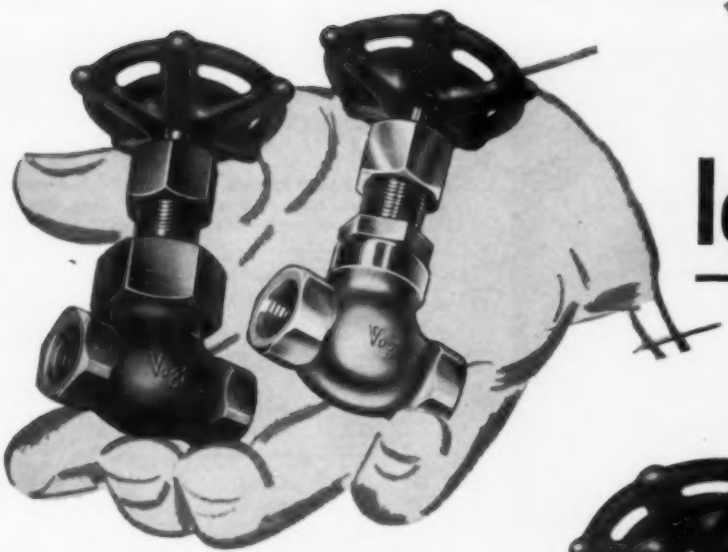
1961 DESIGN ENGINEERING SHOW
Cobo Hall, Detroit May 22-25

ASTME TOOL EXPOSITION
Coliseum, New York May 22-26

Don't miss HYDRAULICS & PNEUMATICS' show feature in the May issue, *Fluid Power Components . . . how far have we come? . . . where are we going?* It surveys user opinion, forecasts development trends.

New higher quality

New lower price



Enlarged production facilities combined with improved manufacturing techniques enable Vogt to pass on the effected savings to our customers.

Service proved — these valves have always been a standard of quality for meter and gauge line service. You no longer need to compromise for less because of price! Send for Folder GP-9 giving specifications and engineering data on both globe and angle types, forged from stainless or carbon steel for every meter and gauge line service.

Address Dept. 24A-FAH.

METER & GAUGE LINE

Vogt

VALVES

HENRY VOGT MACHINE CO.
Louisville, Kentucky
SALES OFFICES: Camden, N. J., Charleston, W.Va., Chicago, Cleveland, Dallas, Los Angeles, New York, St. Louis.

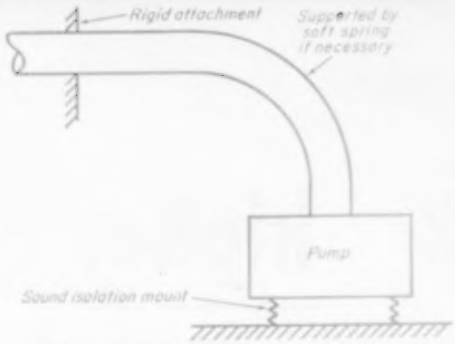


FIG. 1. RUBBER HOSE for isolation should be installed in 90-degree configurations.

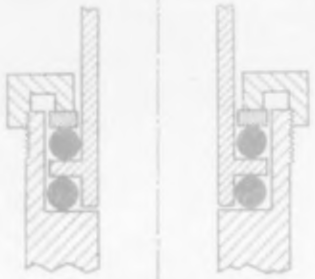


FIG. 2. ISOLATORS may be used when building codes forbid rubber hose.

FIG. 4. TO DAMP PIPING, it should be tightly wrapped with fiberglass tape, or strip steel. Steel strap should be pulled tight and spot welded.

Reducing hydraulic noise

• By **EDWARD M. HERRMANN,**
Machinery Accoustics Consultant, Severna Park, Maryland

Noise is a design factor in hydraulic elevators, operating tables, submarines, and other equipment. Here are some pointers to help you design quiet hydraulic systems.

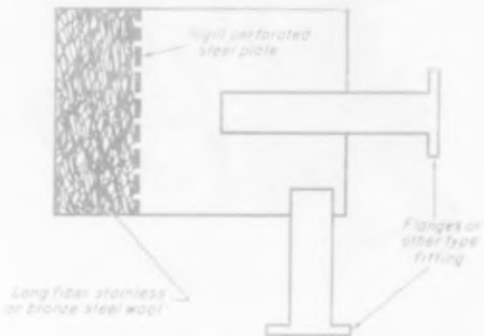


FIG. 5. DISSIPATIVE MUFFLER using long fiber, metallic wool, must be thoroughly washed to prevent fiber contamination of the hydraulic system.

HYDRAULIC noise results from pump and drive motor operation, fluid flow, and piping vibration. It can be reduced by insulating, damping, and isolating noise sources.

• **Noise Insulation**—Building structures are usually poor sound propagators, but occasionally, machinery is placed on a soft floor which may be excited easily. Machinery should be isolated from the supporting structure, and isolation should have as low a natural frequency as possible. The ratio of the lowest exciting frequency to the system's natural frequency should never be less than 3: the natural frequency of the mountings used (cps) at the load supported by them should not be greater than 1/3 of the lowest pump or motor rpm. To obtain the natural frequency required, isolation can be done with neoprene rubber pads, or other commercially available mountings.

The hydraulic piping system should be completely isolated from the noise sources. This can be done with wire-reinforced rubber hose. Rubber hose is better than other isolation methods because it provides a pressure-relieving effect to sound pulsations. Thus it acts as a sound absorber. Hoses should always be installed in 90-degree configurations as shown in Fig. 1, and each leg should be at least 9 in. long. The configuration should be unsupported, but can be supported with a very soft spring at the center if necessary.

If building codes forbid the use of hose, other types of isolation are available. The O-ring isolator shown in Fig. 2 is not as effective as the hose configuration in the axial direction because the rubber O-ring acts as a fluid and is incompressible and rigid. This isolator should always be installed close to the pump. The isolator should not be constrained. The pipe after the isolator should be rigidly fastened, preferably to a massive wall. Elbow radii should be at least four times pipe diameter as shown in Fig. 3.

• **Damping Piping**—Isolators are only partially effective. To further reduce noise propagation, and prevent resonance excitation, piping can be damped as shown in Fig. 4. Damping is not required on couplings, flanges, valves, or other fittings.

Where possible, piping should be supported by pipe

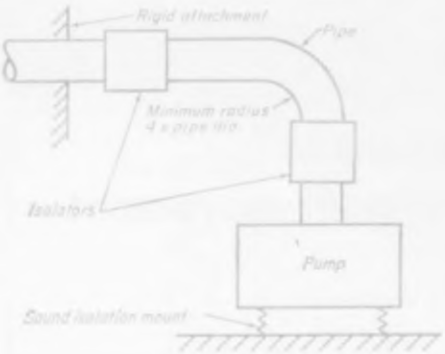


FIG. 3. FORMED ELBOWS used with isolators should have a bend radius at least four times pipe diameter.

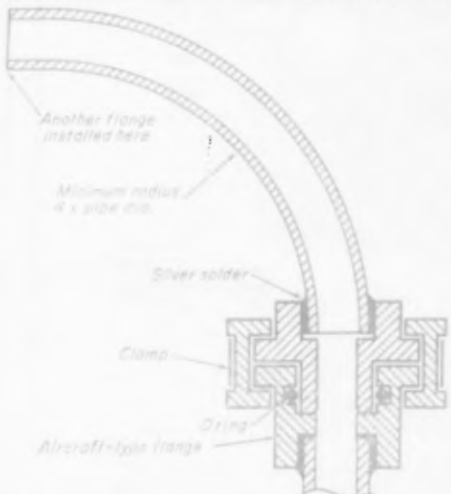


FIG. 6. BENT TUBING RADIUS should be at least four times tube diameter. Installation can be simplified with aircraft flanges.

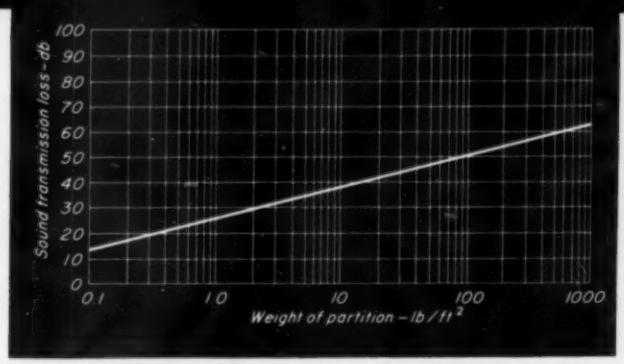


FIG. 7. SOUND TRANSMISSION is reduced by insulating the pumping room. Sound reduction is a function of partition weight.

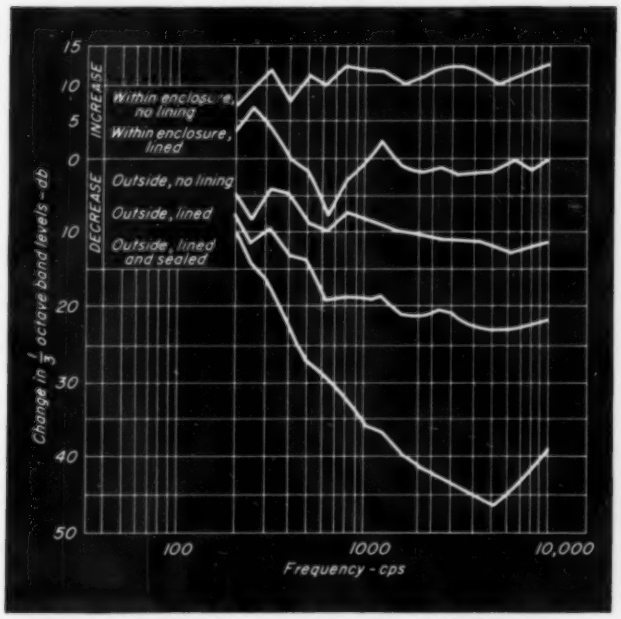


FIG. 8. LINING INSIDE of enclosure provides sound reduction.

hangers rigidly attached to structure. In hydraulic elevators, piping should not touch other parts of the elevator structure, especially not the guide rails. Guide rails should be attached rigidly to the building structure only, not to structure that supports a hydraulic cylinder.

• **Noise in Fluid**—To reduce sound propagation in fluids, it is necessary to use dissipative mufflers for broad band noise, or tuned mufflers to reduce a narrow band of frequencies. Since broad band noise exists in most hydraulic systems, dissipative mufflers are the most effective. The muffler shown in Fig. 5 is effective. This long fiber, metallic wool must be washed in oil to prevent fibers from entering the hydraulic system. The muffler should be installed after the pipe isolator, and should be supported rigidly.

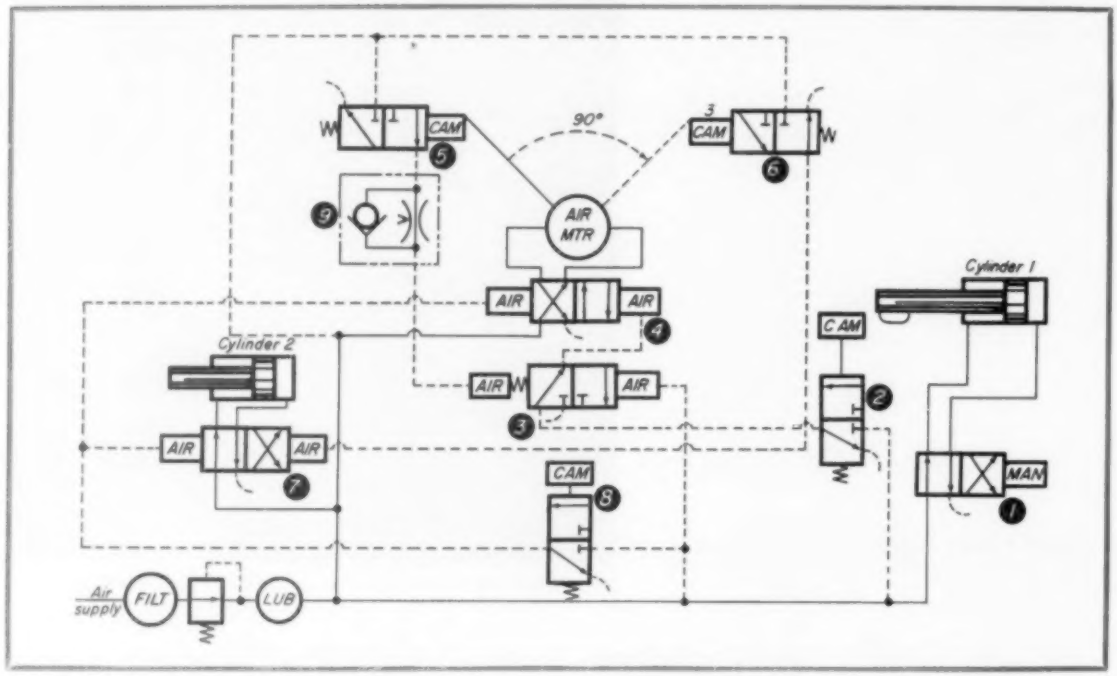
• **Reynolds Number and Noise**—To prevent the hydraulic fluid from generating sound in the piping system, fluid velocities should be kept as low as possible. Tests have shown that where fluid velocity exceeds a Reynolds Number of 2200 (turbulent flow), there is more noise than with lesser Reynolds Numbers (laminar flow). Commercially available, 90-degree elbows generate noise because of flow. To reduce noise created by fittings, formed elbows should be used. They should have a bend at least four times pipe diameter. To make it easier to install the elbows they can be fitted with aircraft type flanges as shown in Fig. 6.

Valves in the hydraulic system can also generate noise, particularly when a valve gate is not wedged tightly in the open position and rattles when fluid passes through it.

• **Cover Box Reduces Noise**—Where it is impossible to have a heavy wall separate the machinery room from the elevator shaft, it might be preferable to completely enclose the pumping equipment with a removable box. The weight of the box will provide the magnitudes of attenuation shown in Fig. 7. Lining the box will provide additional reduction. Air leaks not suitably baffled will decrease the effectiveness of the box. Fig. 8 shows the effect of lining the enclosure with sound-absorption material. The results shown for this small enclosure can be extrapolated for a large room. Thus lining the machinery room reduces the noise escaping to the outside. ▼▼▼

Pilot circuit sequences air motor and cylinder movement

• By W. C. THOMPSON,
Hannifin Div., Parker-Hannifin Corp., Des Plaines, Ill.



ACTUATING a manual, 4-way valve in this circuit starts a sequence which extends one cylinder, rotates an air motor 90 degrees, extends a second cylinder, returns the air motor to its starting position, and retracts the second cylinder. The first cylinder remains extended, and the sequence continues as long as the manual, 4-way valve remains in its operated position.

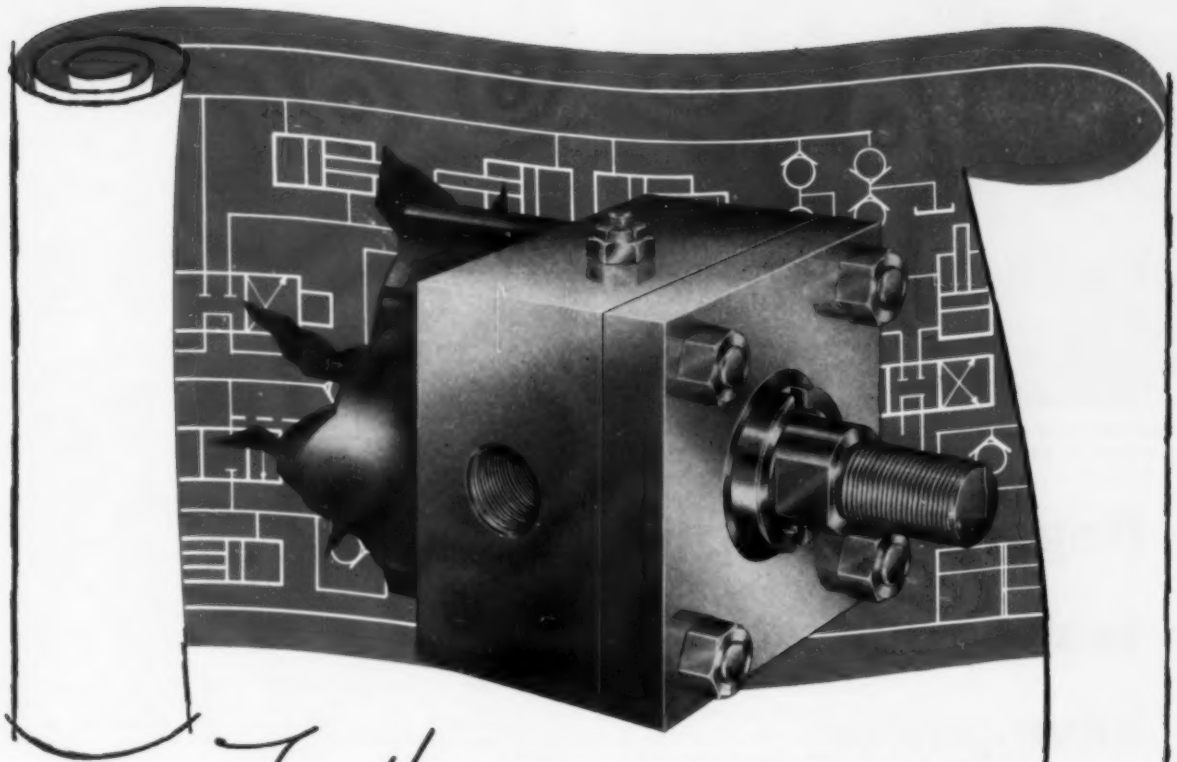
• **How It Works**—Manual valve 1 is shifted, extending cylinder 1. A cam on cylinder 1 opens cam valve 2 and directs pilot air through valve 3 to valve 4. Since air pressure is applied to both actuators on valve 3, a spring at one end shifts and holds the valve in the position shown. Valve 4 shifts, reversing flow to the air motor and rotating it clockwise. When the motor releases cam valve 5, the valve shifts and bleeds air from the actuator on valve 3. Valve 3 shifts, exhausting the actuator on valve 4. However, valve 4 does not shift because both of its actuators are exhausted.

The air motor continues its clockwise rotation and actuates cam valve 6. Air flows through valve 6 to the actuator on valve 7. Valve 7 shifts, extending cylinder 2.

At this point in the cycle a workpiece rolls into a fixture and actuates cam valve 8. Valve 8 shifts and directs air flow to the actuators on valves 7 and 4. Valve 4 shifts immediately, rotating the air motor counterclockwise. Valve 7 shifts after the air motor releases cam valve 6, exhausting the actuator on valve 7. Cylinder 2 retracts.

When the air motor returns to its starting position, it actuates cam valve 5. The time delay between cycles is determined by how much air is allowed to flow through valve 9 to the actuator on valve 3.

The cycle continues as long as cylinder 1 holds cam valve 2 actuated. To stop the sequence, manual valve 1 is shifted to retract cylinder 1. This shifts cam valve 2. Air from the actuator on valve 4 exhausts through valves 3 and 2. When the air motor actuates cam valve 5, the cycle stops. ▼▼▼



For the BLUEPRINT of your products...

SPECIFY T-J CYLINDERS . . . FOR YOUR POWER DRIVE DESIGN • APPLICATION OR REPLACEMENT MAINTENANCE

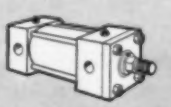
From its blueprint stage to its maintenance engineering requirement sheet, your product will assure MORE power drive precision and service, if T-J cylinders are specified. T-J's complete line too, from the Spacemaker to the new replaceable Squair Head, can be the answer to any power problem. Write or call The Tomkins-Johnson Company, 2425 W. Michigan Ave., Jackson, Michigan, today!

T-J OFFERS THE ONLY COMPLETE CYLINDER LINE

STANDARD HYDRAULIC

STANDARD PNEUMATIC

AIR and HYDRAULIC SPACEMAKER



AIR and HYDRAULIC SQUAIR HEAD

HIGH PRESSURE SPACEMAKER

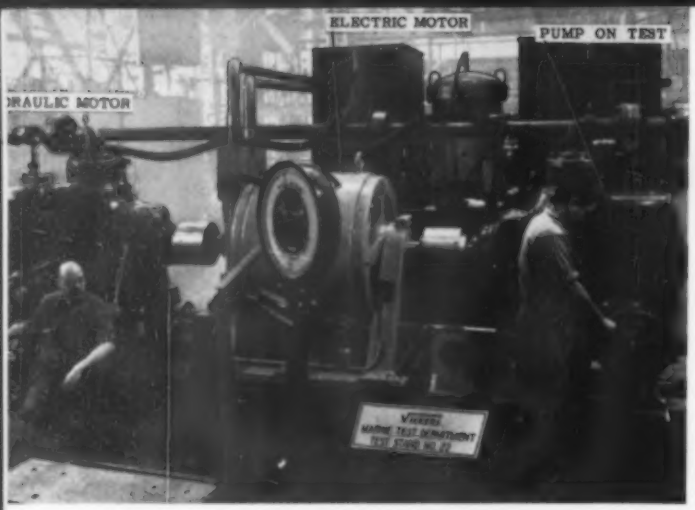
PLUS complete catalog service

T-J **TOMKINS-JOHNSON**

RIVITORS...AIR AND HYDRAULIC CYLINDERS...CUTTERS...CLINCHORS

Representation in all major areas, including Canada.

Circle 118 on Reader Service Card



REGENERATIVE CIRCUIT installation for testing large (320 gpm) pump used in marine applications. Circuit is similar to that shown in Figure 1.

Regenerative test circuits save power

• By **JOHN D. DIETIKER,** *Laboratory Manager, Mobile Hydraulics Div., Vickers, Inc., Detroit, Mich.*

WHEN life testing large hydraulic pumps and motors, consider the regenerative circuit which requires less input horsepower. In this system, the test pump output drives a hydraulic motor, and this motor returns driving energy to the pump drive-shaft. Pump output flow is connected to the fluid motor. Both the electric motor and fluid motor shafts are coupled to the pump.

Depending on the relative rates of pump output to motor intake, electric motor input power only needs to be large enough to compensate for mechanical and hydraulic losses. To test a 100-gpm pump at 3000 psi (hydraulic output is about 175 hp), a regenerative circuit would require power input of only 30 to 40 horsepower instead of an estimated 200.

• **Testing With Variable Displacement Motors**—An electric motor with a double-end drive shaft is coupled to a test pump at one end, and a fluid motor at the other, as shown in Figure 1. Pump outlet is connected to fluid motor inlet. If pump and motor have the same displacement and rotate at the same speed, it is not possible to build up hydraulic pressure. However, when hydraulic motor displacement is slightly smaller than test pump displacement, excess flow discharges through the relief valve, whose setting controls test pressure. The double-end electric motor shaft now transmits fluid motor output to the pump drive shaft and simply makes up for mechanical and hydraulic losses. This direct-coupled method can be used only when test speed of the hydraulic units matches a standard, nominal electric motor speed (such as 900, 1200, 1800, or 3600 rpm) less electric motor slip. When these speeds do not match, the required speeds are obtained by selecting proper belt-drives, as shown in Figure 2.

• **Testing With Fixed Displacement Motors**—In the preceding examples, hydraulic pressure is built up with a variable or fixed displacement motor whose displacement is slightly smaller than that of the pump. When using a fixed displacement motor of equal or

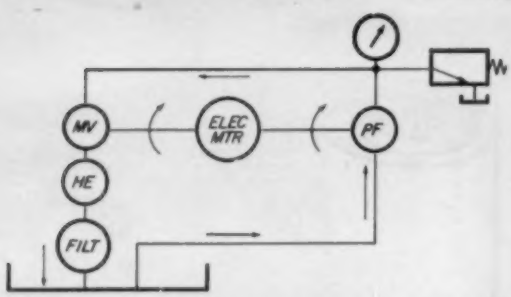


FIG. 1. DOUBLE-ENDED electric motor drives a fixed displacement pump. Pump output drives a variable displacement hydraulic motor, mechanically connected to the electric motor and hydraulic pump. Ideal when pump output slightly exceeds motor intake.

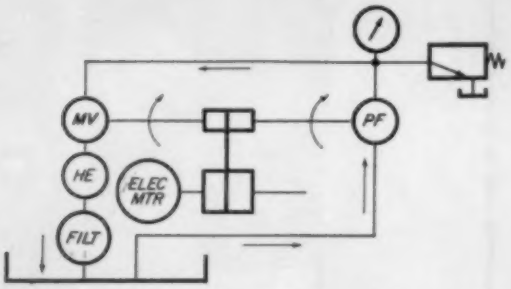


FIG. 2. ELECTRIC MOTOR drives fixed displacement test pump through a belt drive. Pump hydraulic output drives hydraulic motor which is connected mechanically to the pump shaft through the driven-sheave shaft.

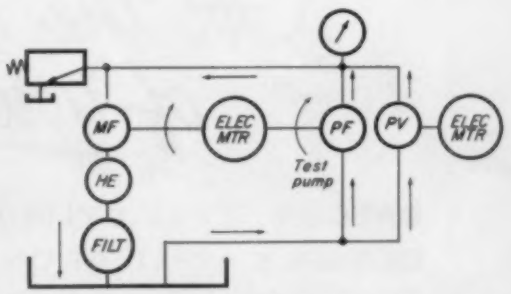


FIG. 3. FIXED DISPLACEMENT motor in circuit is used as power feedback. Smaller, auxiliary, variable displacement pump controls pressure.

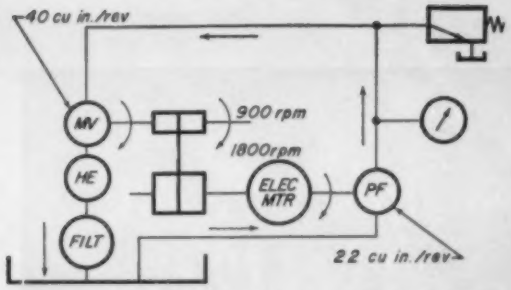


FIG. 4. BELT DRIVE from hydraulic motor efficiently uses a motor of displacement different from pump.

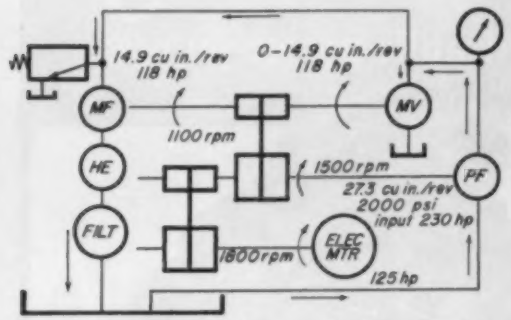


FIG. 5. BELT DRIVES suit pump speed to electric and hydraulic motor speeds. Two smaller displacement hydraulic motors match pump displacement.

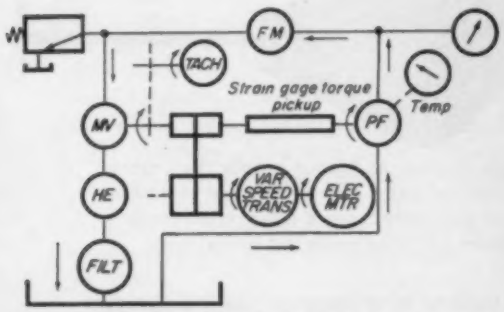


FIG. 6. PERFORMANCE TEST CIRCUIT has a variable speed drive and instruments to measure input and output horsepower.

slightly larger displacement than the pump, a modified circuit is needed.

Output from a small auxiliary pump is connected into the regenerative circuit, Figure 3. Now, hydraulic motor intake is smaller than the combined deliveries of the test and auxiliary pumps. Excess flow discharges through the relief valve, whose setting determines test pressure. This circuit is excellent for simultaneous life tests of fixed displacement pumps and motors.

• **Controlling Displacement With Belt Drives**—In examples illustrated by Figures 1, 2, and 3, hydraulic pump and motor displacements were nearly matched. This insured pressure build-up and maximum mechanical feedback into the drive system. When displacements of test pump and motor are completely mismatched, as shown in Figure 4, a belt drive of suitable ratio will slow down or speed up the motor to bring its intake within range of pump output. Some fluid will discharge through the relief valve, whose setting determines test pressure.

An alternate plan for any of these circuits is to use a pressure compensator control on the variable displacement unit. It automatically varies displacement and maintains desired test pressure. This device has a hydraulically actuated, spring-loaded piston which reduces pump displacement (or increases hydraulic motor displacement) as pressure increases. The auxiliary pump in Figure 3, and the hydraulic motors in Figures 1, 2, and 5 could be compensator controlled. This is an efficient system, because there is no discharge through the relief valve. The only heat in the entire system is from internal leakage and losses. In examples shown in Figures 1 through 4, the regenerative circuit conserves power and holds heat rejection to a minimum.

• **Testing With Two Motors**—If there is no hydraulic motor to match the size of the pump to be tested, two smaller motors, one fixed displacement and the other variable can be used. The two motors are coupled to a common shaft and through belt drives to the test pump drive shaft, as shown in Figure 5. If required pump test speed is not a nominal electric motor speed, a belt drive of suitable ratio is installed between the electric motor and pump. The variable displacement motor is regulated so that together with the fixed displacement motor the combined intake is slightly less than test pump delivery. The small excess of flow discharges through the relief valve, whose setting determines test pressure. In the circuit of Figure 5, only part of the electric motor capacity (125 hp) is needed to drive the test pump (input requirement 230 hp).

• **Performance Testing**—A modified, regenerative circuit may be used for performance testing. These tests measure pump input torque and output flow. A strain gage type torque pick-up is placed between the pump shaft and the shaft carrying the driven sheave, as shown in Figure 6. A turbine type flow meter is connected to the pump discharge line. It is usual in performance testing, to drive the pump at various speeds through a hydraulic, mechanical, or electric variable speed drive. Speed and torque readings show pump input power. Pump flow and pressure readings show hydraulic output power.

• **Regenerative Circuit Cost**—The initial cost of a regenerative system (including hydraulic motors, belt drive, and other equipment) is usually the same or a little more than the initial cost of a conventional circuit that uses larger prime movers and cooling equipment. Operating cost of the regenerative circuit is much less.

The regenerative circuit is satisfactory and economical to test large hydraulic pumps or motors. It should be considered particularly for tests where power supply and heat dissipating facilities are limited. The savings in power and lower heat generation may also make it possible to run several test stands at the same time. ▼▼▼

ADEL ...offers you *single source* responsibility

for precision hydraulic power pumps

CONSTANT DISPLACEMENT GEAR TYPES WITH ELEVEN DIFFERENT GALLONAGE OUTPUTS... DESIGNED FOR 1000 PSI SERVICE WITH RATED CAPACITIES OF FROM 1.4 TO 47.5 GPM AT 1800 RPM

Precision-built for long, trouble-free service under the most severe operating conditions, they exceed the requirements for a low cost, efficient power source. Highest volumetric and hydraulic efficiency—rugged simplicity—only two moving parts—the impeller assemblies, which roll together with minimum wear and horsepower loss.

* **Pumps operate at higher speeds than most competitive units and permit use of smaller pumps and motors for a given horsepower requirement, thus reducing initial cost.**

* **The unusual drive design of the impeller gear minimizes wear between the gear and end plates. Pumps are self-lubricated. No grease fittings to service and no external drain required.**

* **Special shaft seal assures positive sealing, eliminates packing difficulties. Precision gear type construction makes a quieter operating pump. Ratio of volume output to pump size unusally high.**

The Pumps With Maximum Operating Efficiency Over The Years
Let ADEL be your **single-source** *for* **precision hydraulic equipment**
Write for pump brochure containing complete specifications.

NEW DIMENSIONS IN reliability

ADEL PRECISION PRODUCTS

Designers and Manufacturers of
INDUSTRIAL & MARINE
HYDRAULIC CONTROL EQUIPMENT

A DIVISION OF GENERAL METALS CORPORATION
1444 WASHINGTON AVENUE,
HUNTINGTON 4, WEST VIRGINIA
DISTRIBUTORS IN PRINCIPAL CITIES
THROUGHOUT THE U. S. AND CANADA

Circle **3** on Reader Service Card

Circuits for handling shipboard missiles

• By **KURT POLLACK**, *Chief Designer, Special Machinery Div., Baldwin-Lima-Hamilton Corp., Industrial Equipment Div., Philadelphia, Pa.*

A ship's roll and pitch produce erratic loads, even negative loads, in fluid power circuits. Care must be taken to counterbalance such loads. Air's compressibility poses an additional problem. The following shipboard missile handling systems give good control of erratic loads.

TO REDUCE the sensitivity of handling equipment to varying loads, we gear down high-speed motors and use control valves with pressure-gradient characteristics.

Most power drives do not have a self-locking transmission to resist over-running. So a restriction valve with automatic response was designed and installed in the exhaust line of the drive motor. This restriction valve is an effective brake. Also the valve smooths the motor's stopping and starting under load and no load conditions. Flow through the restriction valve increases in proportion to operating pressure.

• **Pressure Gradient Valve Controls Motor Speed**—The circuit in Figure 1 shows a typical basic drive system used on many handling components. First, consider the basic circuit with valve *F* unactuated or completely removed. Control valve *A* is a combined directional and pressure gradient valve. It is a directional valve for the initial movement of its handle. It applies pilot pressure to either side of valve *C* and to relay valve *E*. Actuating valve *E* releases the brake at the predetermined system pressure. Further handle movement controls the pressure gradient function of valve *A*. This increasing pressure at port 4 governs relay valve *B*, which applies an equal pressure, but larger air volume through valve *C* to the motor. Restriction valve *D*, governed by the same control pressure, opens to control motor speed.

With the handle of valve *A* in a fail-safe, neutral position, ports 1, 2, and 4 are vented to atmosphere. This centers valve *C*, closes valve *B*, and reverses valve *E* to apply the spring-actuated brake.

Now consider the circuit of Figure 1 with the addition of cam-operated, slowdown valve *F*. When actuated, it over-rides the operator by blocking his control line and exhausting (closing) restriction valve *D*. This circuit differs from the basic in that minimum flow in the closed position of valve *D* is adjustable to produce the desired deceleration speed.

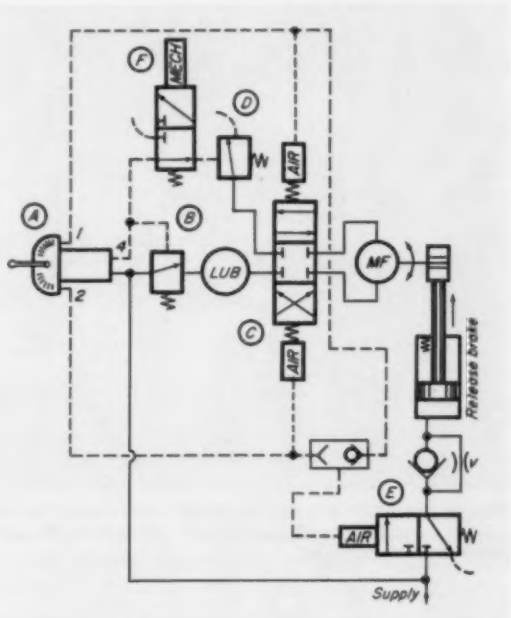


FIG. 1. A TYPICAL DRIVE SYSTEM is manually controlled through valve *A* which is a combined directional control valve and pressure gradient valve. The varying pressure produced at port 4 controls the speed of the motor.

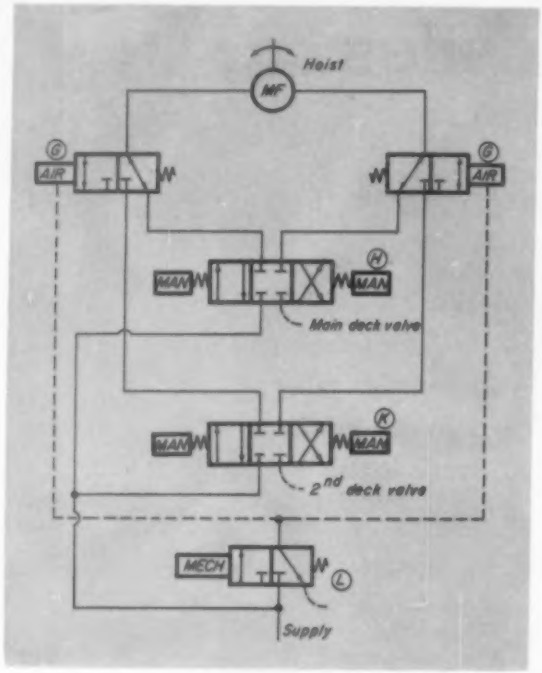


FIG. 2. CONTROL SWITCHING CIRCUIT allows the hoist motor to be controlled from different locations. It is also an interlock circuit. The motor can be restarted only from the distant locations.

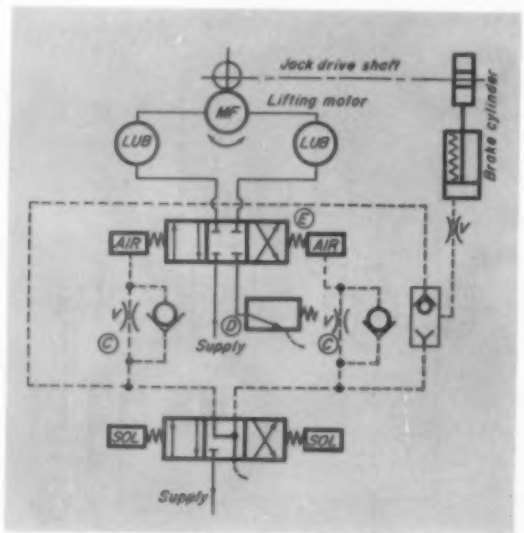


FIG. 3. SMOOTH STARTS & STOPS are permitted by flow control valves **C**. Valve **D** prevents over-running when the jack is driven down under load.

● **Change Control Point**—Another basic pneumatic circuit used with variations throughout the missile handling system is shown in Figure 2. It is both an interlock type and control switching circuit used where control has to be taken away automatically from one operator and given to another at a different location. The load being moved trips valve *L* and is mechanically held at that station. Valves *G* shift and block control pressure from valve *H*, which is at one location. The load can be moved only by an operator actuating valve *K*, at another location. The same procedure in reverse is followed on the return trip.

Adaptations of these basic circuits and other circuits were used for a missile booster car. Its electrical circuit has many limit switches for interlocking, indexing, and operating purposes.

● **Smooth Starts and Stops**—Restrictive pressure, characteristics of a counterbalanced circuit, controls

HYDRAULIC-PNEUMATIC

For top side handling of the Talos warhead and components, we developed a combination hydraulic-pneumatic jib crane. It is for installation on the *Long Beach*, the first atomic cruiser of the U. S. Navy.

Performance criteria required the following major design features:

- A drum type hoist for lifting and lowering: boom mounted and low pressure air-operated.
- Longitudinal motion of the boom and slewing (rotating) of the crane: hydraulically powered.
- Automatic safety features independent of the operator's control.
- All operating valves fail-safe: closed center and spring-centered.
- The boom cylinder and slewing drive motor: counterbalanced to reduce the effect of erratic and negative loads.

Components of the hydraulic and pneumatic circuits are housed within the stationary jib crane base. Flow passages to the moving parts of the crane are in the crane's post, using a multiple swivel joint. Telescoping pipes are used for the hoist feed. All stop positions are locked by either purely hydraulic means or hydraulically released, spring actuated brakes. Both means are applied automatically. Mechanical stops are approached at reduced speed as controlled by cammed, pilot-operated, restriction valves, or built-in dashpots.

This system has been thoroughly tested for performance to design criteria.

● **Heat Exchanger Not Needed**—Tandem center valves unload the pumps, to avoid the need for a heat exchanger and to prevent creep in the operating cylinders. This feature and two others keep oil temperature within acceptable limits. The 1000-psi pump-accumulator circuit has an unloading valve, and the crane's long lines provide a large heat exchange area.

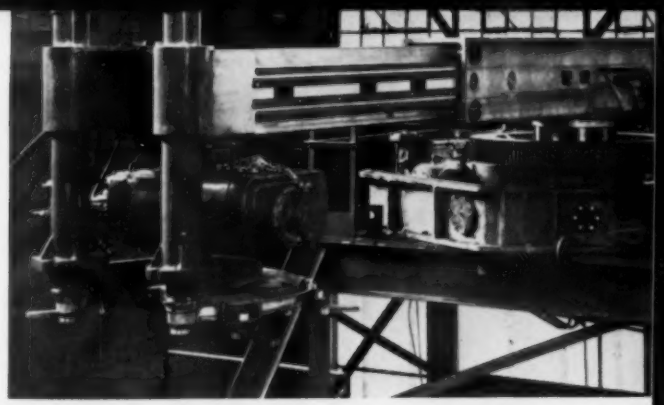
One power unit operates either of two cranes. The direction of oil flow is selected through valve *A* when the operator presses the pump start button at either of two remote control panels. A hand operated pump is provided for manual operation of all crane components in case of power failure.

● **Regenerative Circuit Extends Boom**—To keep pump size small, a differential or regenerative circuit is used to extend the boom cylinder. Valve *M* directs oil to the cylinder head during extension only. The check valve prevents oil from shuttling from one cylinder end to the other due to ship's motion when valve *L* is in neutral.

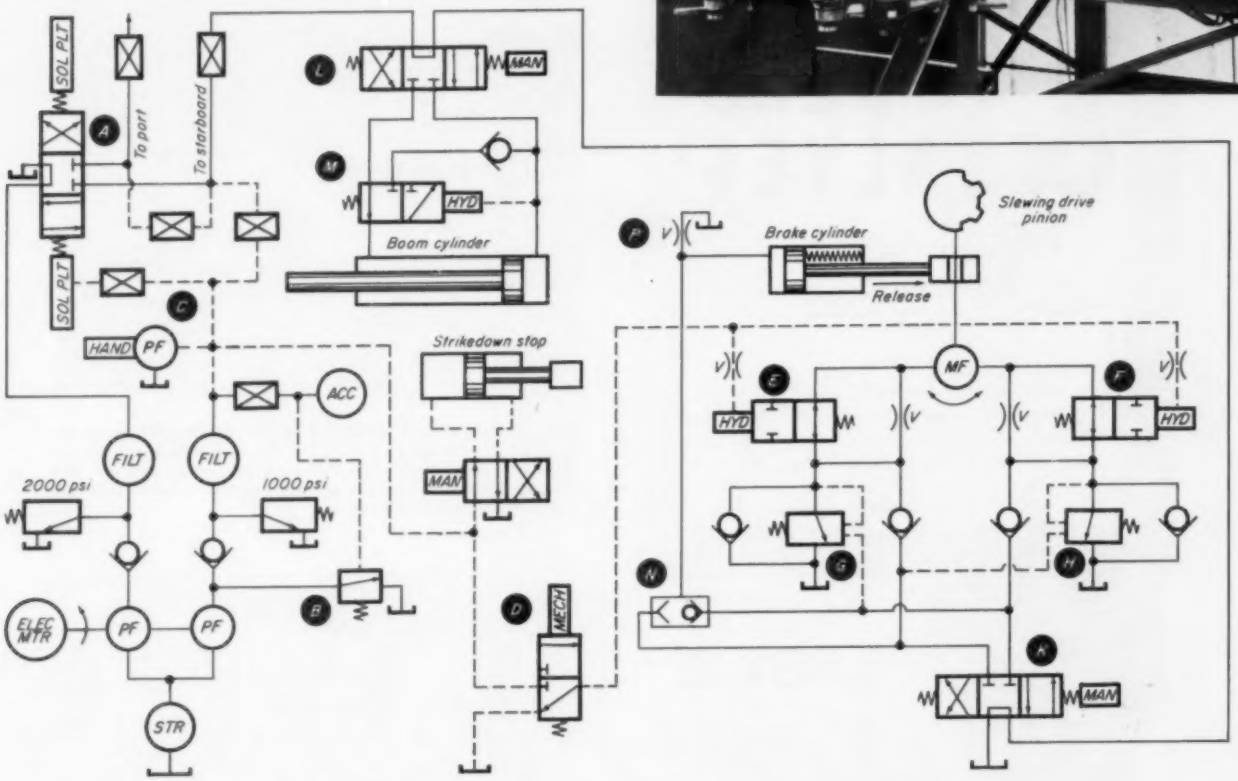
The slewing drive motor is controlled by valve *K*. Moving *K* to the right, directs oil to the motor through valve *E* and the restrictor valve. At the same time, the brake is released, permitting the motor to turn.

● **Combination Counterbalance & Relief Valve**—The ship's roll and pitch results in load changes on the motor. To

CRANE FAILS SAFE



HYDRAULIC CIRCUIT OF THE JIB CRANE for handling the Talos warhead and components. A differential circuit for the boom cylinder speeds its extension only. To prevent over-run due to negative loads, the slewing drive motor is counterbalanced by a combination counterbalance-relief valve.



prevent over-run due to negative load, special by-pass valves *G* and *H* are used. Valve *H* is kept open by pressure in the feed line when there is a positive load on the motor. This permits free downstream flow. A negative load drops the pressure in the feed line and closes *H*, introducing a braking load on the motor. This resistance will exist and vary automatically with a varying negative load. The maximum braking load is determined by the spring setting of valves *G* and *H*. With valve *K* in neutral, *G* and *H* act as braking and relief valves. Oil trapped in the brake cylinder line will bleed through valve *P*, closing the brake at a controlled rate.

Valve *D* is a slowdown pilot valve. Valves *E* and *F* close when valve *D* is actuated. This restricts oil flow to the motor to that flowing through the restrictor valves only.

The strikedown stop positions the crane above the hatch through which the missile components are lowered. It is retracted when the crane is rotated past this position, into stowage position. ▼▼▼

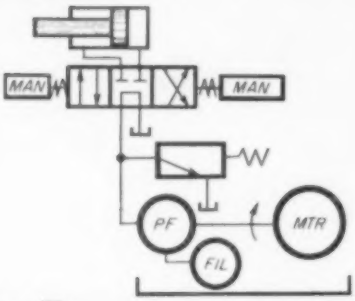
---

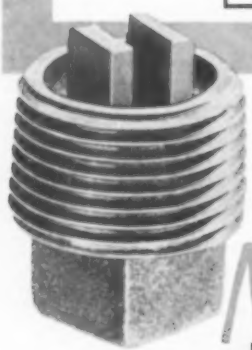
the motor of the lifting jack in Figure 3. The motor is push-button operated with provisions for smooth start-stop operation. Flow control valves *C* regulate shifting speed of valve *E*. When driven down with a load, the jack is prevented from over-running by the restrictive pressure generated by valve *D*.

• **Interlock With Over-ride**—The interlock circuit in Figure 4 stops the booster car at a fixed position. Then the operator can over-ride the circuit to move the car on. A cam mounted on the moving booster car actuates valve *F*. This connects the head end of the stop cylinder and the pilot of valve *G* to exhaust, retracting the cylinder and raising the stop. To move the car on, the operator lowers the stop by shifting valve *G* manually. Differential pressure extends the cylinder, lowering the stop. As the car rides off valve *F*, air flows through valve *F* to the pilot of valve *G*. When the operator feels this pressure on the manual control, he releases valve *G*. Air pressure applied through valve *F* shifts valve *G* and holds the cylinder extended (stop lowered).

• **Either-Or Circuit**—A typical *either-or* circuit is shown in Figure 5. It uses, however, only one pilot valve. The shoe slides can be opened either by energizing the solenoid of valve *H* or shifting its lever. Pressure applied to the pilot of valve *K*, shifts it to connect

REDUCE PUMP WEAR & FOULED VALVES





with

LISLE *Magnetic* PLUGS

Controlled tests have proved that Lisle Magnetic Plugs increase pump life up to 300%, and greatly reduce the problem of fouled valves.

A Lisle Magnetic Plug, installed in the flow path or sump, picks up any ferrous metal particles in the fluid. Removal of these particles eliminate a primary cause of pump wear and fouled valves.

LISLE CORPORATION
CLARINDA • IOWA

Write for Catalog and Test Samples.

Circle **72** on Reader Service Card

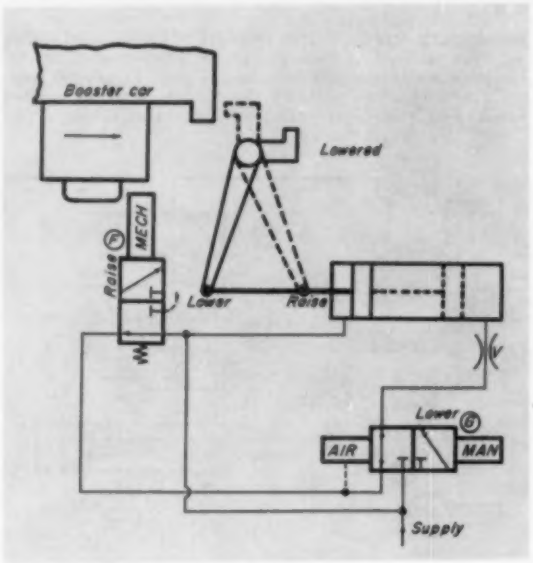


FIG. 4. INTERLOCK CIRCUIT WITH OVER-RIDE stops the booster car at a fixed position. The operator then over-rides the circuit to again move the car. As the car moves on, valve **G**'s manual control pushes against the operator's hand, signaling actual movement of the car.

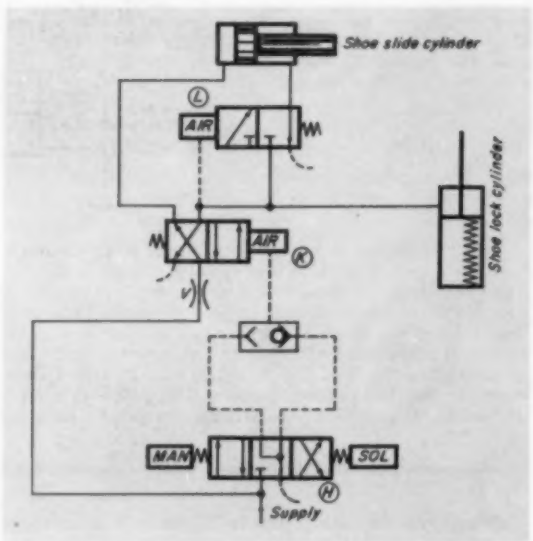
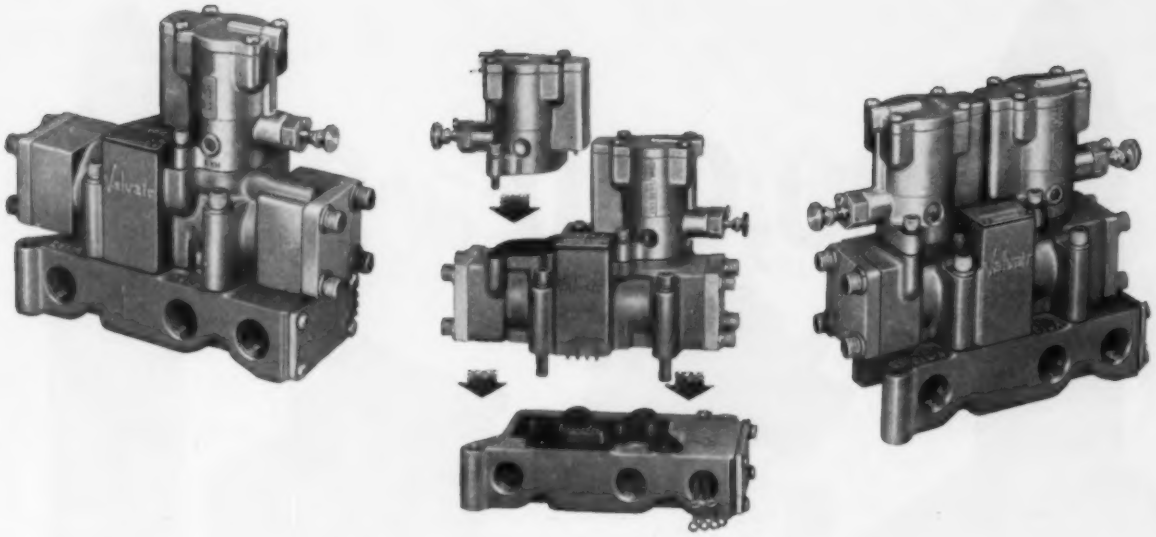


FIG. 5. LOCAL CONTROL OR REMOTE CONTROL of the same operation is possible with this ***either-or*** circuit. The double check valve allows valve ***K*** to be actuated from either position of valve ***H***.

the shoe lock cylinder to pressure. Line pressure increases after the lock cylinder is retracted. Then relay valve *L* shifts, admitting air to the rod-end of the shoe slide cylinder. When valve *H* is de-energized (or released), the slide and lock cylinders extend simultaneously. A lock pin snaps into place after the slide reaches the lock position. ▼▼▼



4-way single or double pilot-operated types, for sub-base or manifold mounting. Aluminum and stainless steel components assure multi-million cycle dependability. Interchangeable pilots, with coils guaranteed against burn-out for life of valve, fit any plug-in Speed King. Coils for AC or DC, most voltages . . . 35—200 psi range . . . integral junction box . . . optional manual over-ride, sub-base connected external pilot supply . . . ¾ in. separate exhaust ports, ½ or ¾ in. inlet and cylinder ports.

VALVAIR® 1/2 in. NPT PLUG-IN VALVES

Based on the service-proved design principle of Speed King ¼ in. plug-ins, Valvair's ½-¾ in. plug-in valve series provides plug-in convenience and versatility to a wider range of control valve applications.

Electrical and pneumatic circuits are completed automatically when valve and pilot are plugged in . . . bolted down. The result—cost-cutting reduction of original installation and maintenance time. All power connections are made permanently in sub-base or manifold . . . there's no need to disturb piping or wiring for quick in-service maintenance.

What's more, advanced design shortens stroke . . . speeds response. Separate coded (4-wire) circuits on double solenoid models meet JIC requirements. Flow area through valve and sub-base equals or exceeds that of full ½ in. pipe.

Whether your control valve applications are on the drawing board or now in service, it'll pay you to investigate the advantages of Valvair plug-in design. A call to your nearby Bellows-Valvair field office will bring prompt application engineering recommendations.

For more information, write for Bulletins SPL and DPL. Address Bellows-Valvair, Akron 9, Ohio, Dept. AH-461.

Bellows-Valvair

AKRON 9, OHIO

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

8170

20,000 OR 20

FROM SIMPLE SHUT-OFF TO COMPLEX CONTROL

Standard Valve Division of Hydraulic Research and Manufacturing Company has produced thousands of basic hydraulic and pneumatic control valves for the aircraft and missile industry over the past 18 years. Engineering skill has simplified complex systems, and complete compact hydraulic control packages have been developed for individual application. Hydraulic Research specializes in control. Product performance has been proven.

For example:

At left is the Hydraulic Research 3-way Valve No. 50150. More than 20,000 of these units have been used — and are still being ordered. 3000 PSI operating pressure. 3-way, 2-position, solenoid actuated. Available as poppet or slide type. Fully qualified and adaptable to many applications.

At right is an integrated control package specially designed and produced in limited quantity for a particular missile requirement. Accepts electrical and pneumatic input signals, and controls flow to six exterior ports and two manifold mounted servo valves. Weighs approximately 50% of normal installation. Single removable unit. Tubes and fittings eliminated.

What about YOUR valve requirements? Take advantage of Hydraulic Research's engineering experience and reputation for reliability to develop and produce the valves and systems you need.

STANDARD VALVE DIVISION

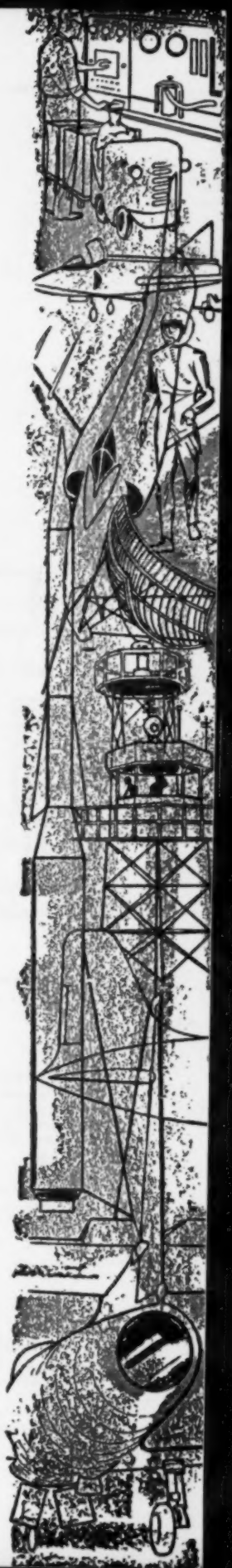
HYDRAULIC RESEARCH and Manufacturing Company

Division of Bell Aerospace Corp.

2835 N. NAOMI STREET • BURBANK, CALIF. • VICTORIA 9-6111

AEROSPACE SECTION

Fluid Systems For Flight and Ground Support



Greer Hydraulics Opens Export Department

An international department has been established by Greer Hydraulics, Inc., Los Angeles, for its line of aircraft ground support and test equipment. It will be operated in New York City by the Allied International Corp. under an exclusive foreign representation agreement with Greer.

AiResearch Operates Cryogenic Test Plant

The Garrett Corporation's AiResearch Manufacturing Co. of Los Angeles operates a cryogenic test plant, designed and constructed under an Air Force contract in 1957, near Boron, Calif. The facility is unique because full scale components can be tested with liquid hydrogen. Liquid hydrogen pumps and heat exchangers can be evaluated, as well as complete systems and associated components using LH_2 as the test fluid. AiResearch has tested cooling and power systems for space orbital vehicles in which hydrogen is both a fuel and cooling agent. Various valve tests can be performed, including flow characteristic checks, leakage checks, and cycle tests. A rotating equipment test cell is designed to run liquid hydrogen pump tests as well as hydrogen powered turbine tests. Hydrogen and oxygen gas manifold systems and a combustion system supply hot gases to the turbine.

Cornelius Receives AF Compressor Contract

A contract for high pressure air compressors has been awarded to The Cornelius Company, Aero Division, Minneapolis, by the Air Force. The compressors will be used with the fuel-air starting system on Boeing KC-135 jet tankers.

Gas Attitude Controls For Rockets

An R&D contract to determine the feasibility of a rocket attitude control system has been awarded to Vickers Incorporated by NASA. The control system, a new concept for orienting rocket vehicles in space, uses a solid propellant gas generator as the energy source. The gases exhaust through a network of proportional valves to produce attitude and roll correction forces.

For more news about fluid systems see page 120

EDITORIAL ADVISORY BOARD

Charles H. Cannon
Lockheed Aircraft Corp.

H. G. Conway
Short Bros. & Harland Ltd.

Howard D. Davis
Convair Astronautics

Kenneth W. Dubois
Douglas Aircraft Co.

Grady Gilder, Jr.
Chance Vought, Inc.

William E. Mayhew
Republic Aviation Corp.

Ralph E. Middleton
Lockheed Aircraft Corp.

E. T. Raymond
Boeing Airplane Co.

John W. Ruffle, Jr.
The Martin Co.

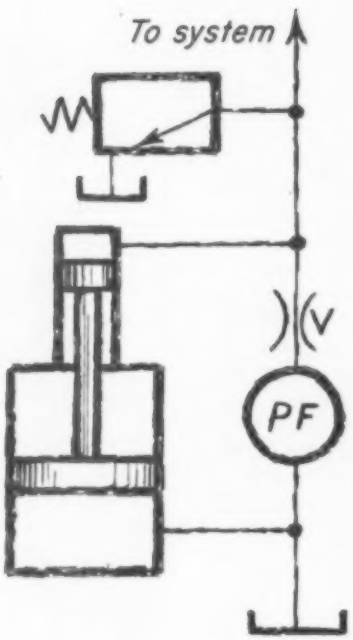
W. F. Talbot
Northrop Aircraft, Inc.

Frank Mladinich
Grumman Aircraft Engineering Corp.

Fast temperature compensation with a bootstrap

• By **MICHAEL VOYTISH, JR.*** and **ROBERT J. GLENN,** *Design Engineer, Convair Division, General*

The ideal missile hydraulic sump and system should be at zero pressure during storage because leakage, should it occur, will be directly proportional to storage pressure. Consequently, the sump must quickly compensate for fluid temperature variations to maintain zero pressure in the sump and system. Also it should supply pump inlet pressure immediately at activation.



BOOTSTRAPPING THE MISSILE'S SUMP permits immediate pressurization of the pump's inlet at system activation. The pump's outlet pressure is applied to the sump. During storage, system pressure is zero.

SPECIFICATIONS FOR A TYPICAL MISSILE HYDRAULIC SUMP

The sump will heavily influence the missile's storage capabilities and hydraulic system performance.

- **It will have to serve under stringent conditions of a missile system requiring high density, hydraulic packaging.**
- **It should deliver 60 ± 10 psi to the pump inlet within 0.1 sec after activation.**
- **It should never impose a pressure greater than 10 psig nor exceed a vacuum of 12" Hg during storage.**
- **The sump should provide temperature compensation during storage without pressurization.**

The missile's hydraulic system will be closed loop, and will be designed for long term (5 year) storage.

- **It will operate at 2000 to 3000 psi—at temperatures from its minimum low storage temperature to the upper limit of the hydraulic fluid.**
- **It will have to meet storage temperatures from —65 F to 160 F and remain in flight readiness.**
- **Oil capacity will be from 20 to 230 cu. in.**

CONVENTIONAL spring loaded or gas charged sumps, because they pressurize the hydraulic system, are not ideal for long term storage. In addition, a gas charged sump might lose its charge, leaving the system suceptible to vacuum, which causes air inhalation and pump cavitation. This results in an inoperative missile requiring field fill-flush and recharging. So the two types of sumps commonly used are not very satisfactory.

• Bootstrap To Pressurize Inlet—It has long been possible to pressurize the pump inlet by bootstrapping the sump. The system and bootstrapped sump are at zero pressure until activation. After spin-up, high pressure outlet fluid is directed against a small piston rod in the sump. This rod is connected to a large area piston on the sump's low pressure side. This pressurizes the pump inlet.

By the calculated differential

**Staff Engineer, Missile Systems, AiResearch Manufacturing Div., The Garret Corp., Los Angeles, Calif. When this article was written Voytish was Group Engineer, Auxiliary Power and Controls, Convair/Pomona.*

sump

Dynamics Corp., Pomona, Calif.

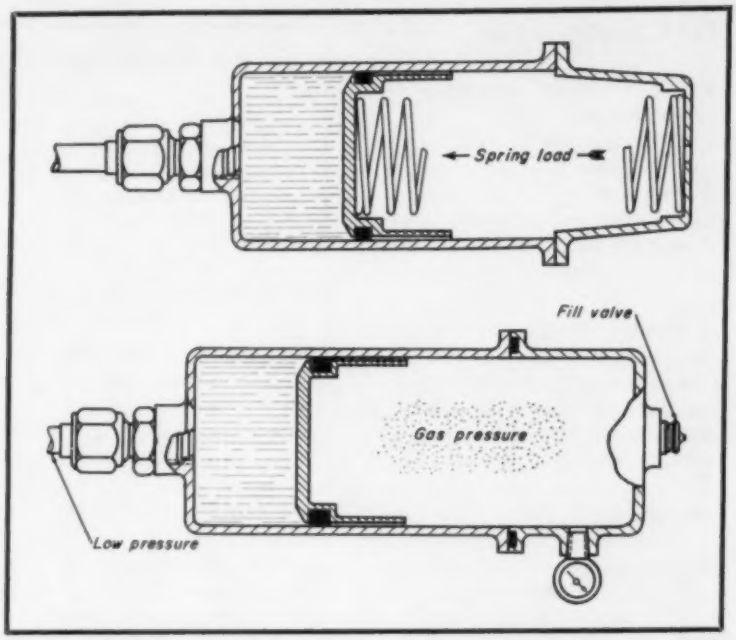
area, a bootstrap sump with a standard O-ring delivered about 60 psi to the pump inlet within 0.1 sec after spin up. The first requirement was easily met.

Immediate compensation for temperature changes during zero pressure storage was not so easy. A seal for this job must have many conflicting characteristics.

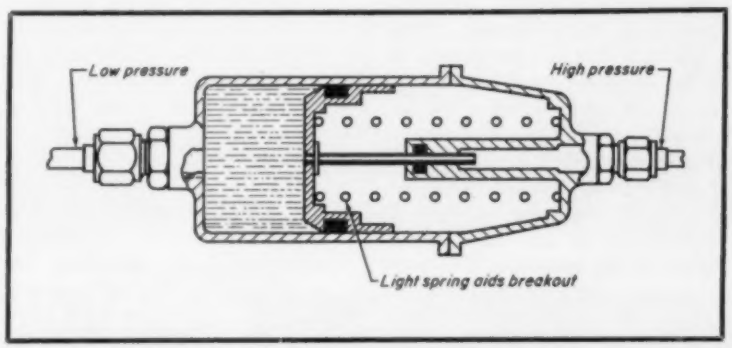
In the common environments required for missile storage, a seal must have enough squeeze to prevent leakage after chilling to —65 F. Yet at normal and higher temperatures, the seal must have a low enough breakout friction to prevent a vacuum from forming in the system. This vacuum would draw in air and cause caviation. The piston must retract quickly when oil expands, and advance quickly when oil contracts. It must also be sealed at all temperatures. These characteristics were the major problems.

• **Low Squeeze Seals Leak**—A bootstrap sump with a standard O-ring seal was tested extensively to get a proper seal design. O-ring seals of many elastomers and sealing surface configurations were tested in grooves of various depths and widths, using different military approved hydraulic fluids. Seals with squeezes from 3.4% to 18.9% were tested under storage environments. Although low squeeze kept breakaway friction within acceptable limits, it also permitted leakage at about —20 F. Higher squeeze required for low temperature sealing, caused too much breakaway friction.

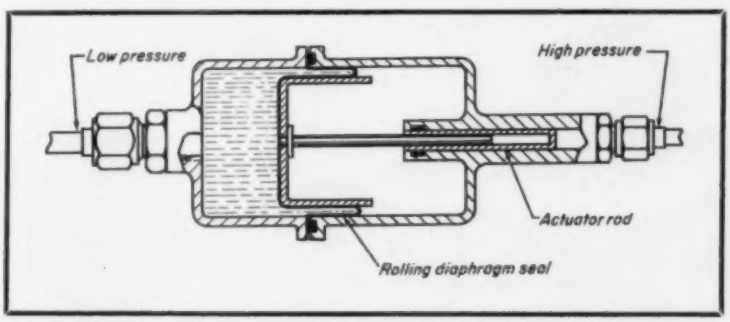
These tests were made under static equilibrium. In operation, breakaway friction was much high-



SPRING-LOADED AND GAS-CHARGED SUMPS are not satisfactory because they pressurize the system in storage. If leakage occurs, system oil will be lost.



BOOTSTRAP SUMP WITH O-RING SEAL leaked during tests at low temperature. When O-ring squeeze was increased to stop leakage, breakout friction was excessive at high temperature.



BOOTSTRAP SUMP WITH ROLLING DIAPHRAGM SEAL has fast temperature compensation and very low breakout friction at high and low temperatures. The piston shaft telescopes into the actuator rod, allowing the O-ring to remain a static seal until system activation.

er and contributed to sump oscillation after activation.

Within the manufacturing tolerances possible for O-rings and at the common storage environment, no solution seemed practical, although the bootstrapping function of the sump proved satisfactory.

• Rolling Diaphragm Seal—The problem of immediate temperature compensation without resulting excessive pressure variation, was solved with a rolling diaphragm seal. The seal is a long stroke, deep convolution, constant area diaphragm. It is made from a fabric membrane impregnated with an elastomer. Both membrane and elastomer can be selected for specific operation and fluid requirements. The seal is attached to the cylinder wall of the sump and rolls up on the piston head.

The seal was sensitive to very small pressure changes, and it also had very low hysteresis. Consequently it had low breakout friction. In actual sump tests, pressure required for breakout ranged from 0.2 psi to 0.5 psi. Although pressure on the piston head may be as high as 100 psi, only 10% or less of the resulting force is transmitted to the seal convolutions during operation. This partly accounts for a cycling life which meets the specific requirements of most missile environments.

A bootstrap sump with a rolling diaphragm seal was manufactured and tested. Bores on the sump needed to be no better than normal machine finish of 125 RMS to function properly with the seal. This eliminated the cost of highly polished grooves and bores in the usual piston-seal combination.

• Actuation Rod Cuts Breakaway Friction—Besides the seal, another unique feature was essential in cutting breakaway friction to acceptable limits. The sump piston shaft telescopes into an actuation rod. This makes the high pressure O-ring a static seal until the system is activated.

This sump was tested under environmental conditions for 17 days. There were no oil leaks nor evidence of air inhalation. The temperature cycling ran from —65 F to 245 F. This was a higher temperature than necessary. During this test, maximum internal oil pressure remained at ±0.5 psig. On activation, the seal operated well. In spin-ups starting from —20 F, the sump delivered 50 psi. On a 125-F start, 58 psi pressurized the pump inlet. After 17 days of testing, the seal was removed and inspected. It showed little wear. After reassembly it was proof tested to 200 psi and held at that pressure without sign of leakage.

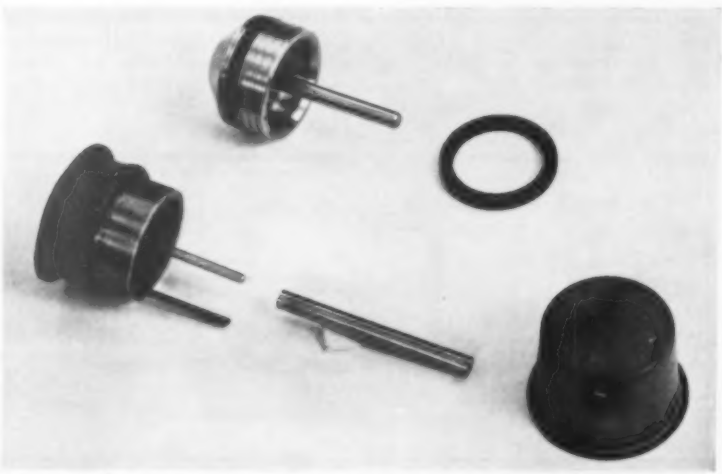
In addition to testing the sump design, seal life was analyzed. A seal was tested at room temperature with a ¼-in. stroke. After 270,000 cycles, there was no sign of fatigue. The seal was cycled 20,000 times at —65 F and at 300 F through a full stroke of 3.72 in. There was no leakage when afterward the seal was then used as a pressure vessel and subjected to 25 psi for ½ hr.

The bootstrap sump with the rolling diaphragm seal is a promising solution to zero pressure, long term storage. With sensitive temperature compensation and immediate delivery of pressure to the pump at activation, this sump design is nearly ideal. All answers to seal life and bootstrapping functions under operating conditions have not been answered, because of limited testing. But the prototype has proved so satisfactory that it looks like a road sign on the way to success. Also, the variety of materials available and the long stroke possible with the rolling diaphragm seal, are a welcome combination to the designer harassed by shrinking space available to hydraulic sections. ▼▼▼

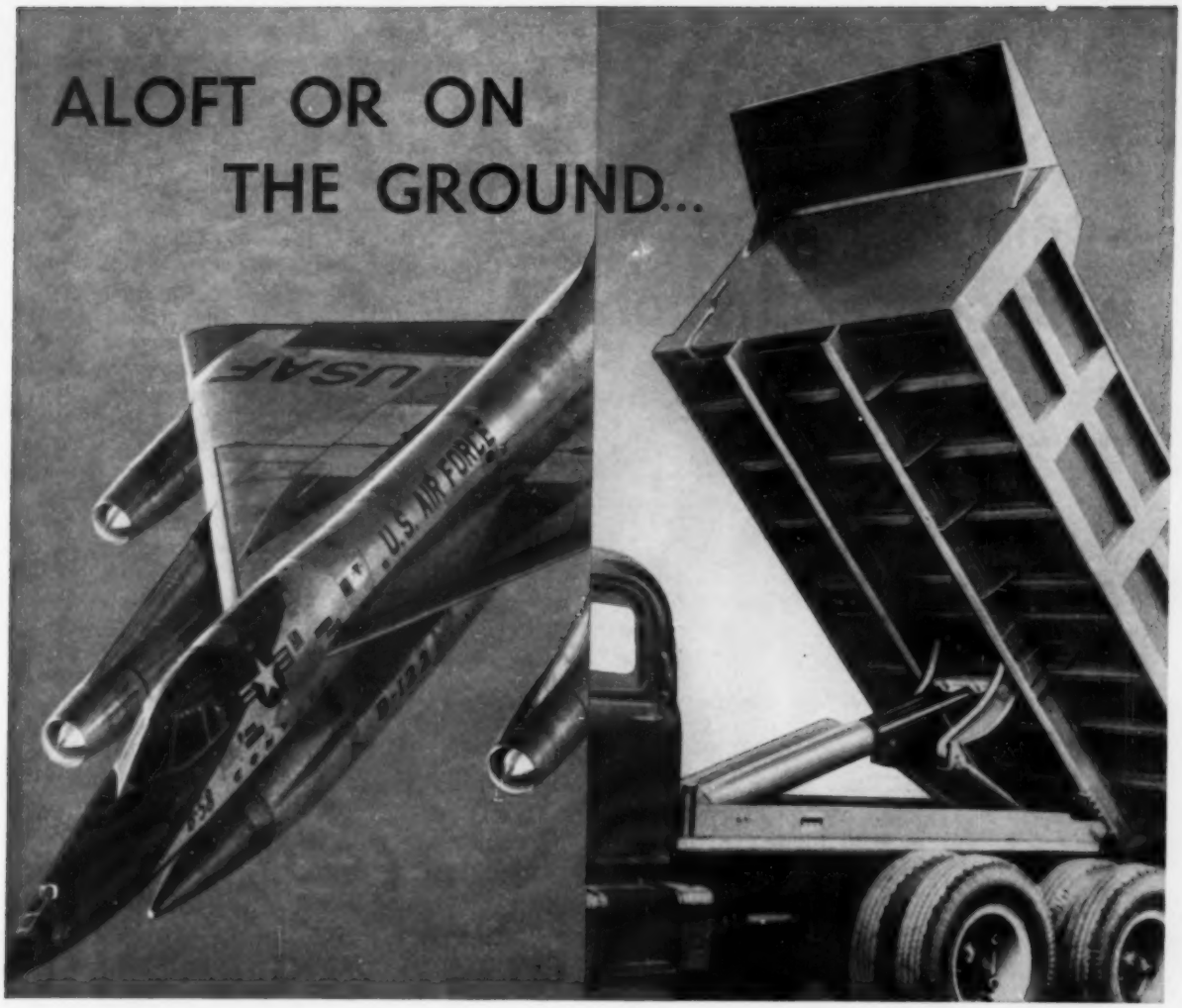
AN IDEAL MISSILE HYDRAULIC SYSTEM

A missile system for long term storage should be non-pressurized. Also the high pressure system should be enclosed in the low pressure reservoir, with a minimum of seals vented to atmosphere. Here are the reasons:

- **Any leakage will be directly proportional to storage pressure.**
- **The seals of the high pressure system will be surrounded with oil, reducing the effect of seepage.**
- **Seals in contact with the atmosphere are always potential points of system oil loss.**



PISTON HEADS with O-ring seal (above) and rolling diaphragm seal (below). The O-ring and diaphragm seals are shown separately. Replacing the O-ring with the diaphragm seal provided very low breakout friction, making the bootstrap sump highly satisfactory. Note the separate actuator rod (below).



Koppers Sealing Rings give ensured actuation!

Koppers solves diverse and difficult sealing problems.

Modern supersonic jets and dump trucks—as dissimilar as they appear—both depend on Koppers Sealing Rings for efficient hydraulic system operation. Koppers *Predictable Performance* Sealing Rings are used in a wide variety of applications . . . engineered to satisfy each requirement of both hydraulic and pneumatic sealing.

Koppers has the technological skill, gained through 38 years of experience, to meet the most critical performance requirements in any sealing application. Look to Koppers to solve your sealing problems. For an informative booklet on Metallic Sealing Rings write to: KOPPERS COMPANY, INC., 6004 Hamburg Street, Baltimore 3, Maryland.

A Koppers Sealing Ring is applied to a B-58 actuator.

KOPPERS®

SEALING RINGS

Engineered Products Sold with Service

Learning to live with contamination

• By GERALD A. LEVINE*

The contamination problem can be attacked two ways. Control it by filtering and other techniques. Or live with it by using components which are reliable even in a contaminated system.

FLUID contamination discussions dominate every aerospace hydraulic meeting. Though airborne hydraulic systems have been in operation for many decades, the recent upsurge in concern about contamination is attributed to electrohydraulic flight controls—especially servovalves—now included in such systems.

The servovalve has revolutionized high power servomechanism design. Servovalve response is so much faster than competing systems, even in extreme environments, that many programs would not be possible if deprived of this component. Unfortunately, the servovalve is susceptible to contaminants because it has fine metering orifices and close flapper nozzle clearance.

• **SAE Standardizes Procedures**—The SAE committee on missile fluid power systems has done an excellent job of establishing standardized procedures for quantitatively describing, measuring, and controlling system contaminants. The committee fostered the initially very clean system. Transportation of superclean fluid in especially designed very clean containers, and filling the system through high filtration ground carts are used for contaminant control.

Contamination control is good. But an initially clean system does not guarantee trouble-free operation. High speed rotating machinery generates metallic contaminants. Actuators chew up O-rings and back-up rings. Non-elastomeric dynamic seals wear.

Also, tactical servicing is difficult. Will servicing always take place in an area free from airborne dust? Will there always be people of sufficient competence to prevent maintenance introduced contaminants? How long will the system remain clean?

An alternate approach to contamination control is required if hydraulic systems are to perform at high confidence levels, and at competitive costs. This approach is the reduction of susceptibility to contaminants. Three possible areas are described.

• **Higher Power Level**—The electrohydraulic servovalve was developed during the vacuum tube era. So torque motors have been

CLASSIFICATIONS FOR SYSTEM CONTAMINATION

Particle Size, microns	5-15	15-25	25-50	50-100	100 up
System Class, number of particles					
Super Clean	590	150	100	25	13
Very Clean	3,500	660	380	70	30
Dirty	75,000	25,000	18,000	11,000	125

THE NUMBER AND SIZE OF PARTICLES in a 100 ml fluid sample determines the contamination level and system classification of an airborne hydraulic system, according to the SAE committee. One micron is 0.00004 in.

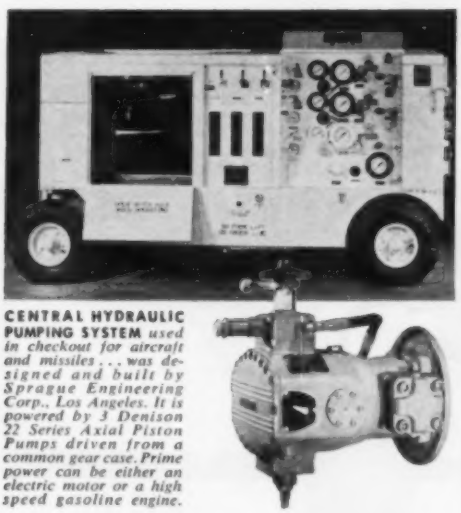
*When this article was written, Mr. Levine was Assistant Supervisor, Mechanics and Hydraulics Project, Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Md.

Denison and Denison HydrOILics are registered trademarks of Denison Eng. Div., ABSCO

DENISON HydrOILics

Flexible, high-accuracy simulation with DENISON hydraulic pump power for...

CHECKOUT



CENTRAL HYDRAULIC PUMPING SYSTEM *used in checkout for aircraft and missiles . . . was designed and built by Sprague Engineering Corp., Los Angeles. It is powered by 3 Denison 22 Series Axial Piston Pumps driven from a common gear case. Prime power can be either an electric motor or a high speed gasoline engine.*

With Denison Variable Volume Axial Piston Pumps powering your hydraulic checkout equipment, you assure *high-accuracy simulation.*

These pumps (with volumes to 116.7 gpm and pressures to 5000 psi) allow a wide range of pressures and flows to be selected with fine-line variations. You get the multi-purpose flexibility needed for today's checkout equipment.

Denison Variable Volume Piston Pumps—and *all* Denison hydraulic components—are precision manufactured for long, maintenance-free life. Result—you can spend more time checking-out . . . less time checking-up.

Ask your Denison Hydraulics Specialist—located in all principal cities—to show you how Denison hydraulic equipment—pumps, motors, valves, controls—can help you improve the performance of your GSE systems.

Write for your copy of new Bulletin 204, "Advanced Hydraulic Components For Ground Support Equipment".

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1166 Dublin Road • Columbus 16, Ohio

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

DENISON
HYDRAULIC POWER

designed to operate with very low currents, typical of subminiature tubes. The first transistors could not equal the power output of tubes. But now transistors have been developed with higher power output capacity and efficiency. These improved transistors can be applied to torque motors, making significant increases in servo power input. This could make single stage valves more attractive in moderate power servomechanisms. Then flapper nozzle amplifiers as well as minute upstream metering orifices could be eliminated.

• **Non-Linear Techniques**—Non-linear servomechanism techniques, such as pulse-width modulation, has freed valves of a silting and magnetic contamination problem. The acceleration switching valve has been demonstrated in the laboratory as well as to a thrust vectoring mechanism on a solid fuel rocket engine, and in a Bureau of Weapons missile program. There are many servomechanism designers today who are competent to design the switching approach into their systems.

• **Leakage**—To reduce energy loss in an electrohydraulic servovalve, leakage must be reduced. Lower leakage requires smaller upstream orifices in a two stage valve, as well as closer nozzle flapper clearances. Smaller orifices and clearances make the servovalve more sensitive to contamination.

But perhaps low leakage is not so important because the energy lost through leakage is small in proportion to other losses.

The whole subject of energy loss (efficiency) is intriguing because of the inherent low efficiency of the constant pressure servovalve configuration. Except for selected thrust vector applications, the primary servo load is inertial or spring type. Both types present conservative energy systems. Yet the hydraulic system expends the same amount of energy whether it drives an actuated flight control surface to its feathered position or the aerodynamic load is allowed to return it. (This is the same amount of energy that the hydraulic system uses to push out the control surface against the aerodynamic load.)

One complete actuator cycle probably wastes more energy than is lost in a missile flight due to valve leakage. Yet system reliability which depends on contamination sensitivity is radically compromised to reduce the leakage.

Contamination is a major problem for the hydraulic designer because it heavily influences his system's reliability, storageability, and tactical handling and servicing. A two pronged solution is necessary. Keep contaminants under control, *and* design out the system's susceptibility to contaminants. ▼▼▼

Solenoid valves for industry

To meet the requirements of industry a wide range of Solenoid Valves have been developed to the following specifications.
Orifice size 0.04 in. upwards.
Normally-open, normally-closed or Three way.
Direct acting or Relay acting.
Temperatures up to 300°C.
Standard, Flameproof or Instrinsically safe.
Hydraulic & Pneumatic.
Pressures up to 6000 p.s.i.

VALVES OR HYDRAULIC SYSTEMS FOR A VARIETY OF APPLICATIONS CAN BE DESIGNED TO CUSTOMER'S REQUIREMENTS — WE INVITE YOU TO DISCUSS YOUR PROJECT WITH US.

EH LIMITED

ELECTRO-HYDRAULICS LIMITED
INDUSTRIAL SALES DEPARTMENT · WARRINGTON · ENGLAND
MEMBER OF THE OWEN ORGANISATION

DON'T FREEZE THAT DESIGN!

Demand for DYNAPOWER®

HYDROSTATIC TRANSMISSION SYSTEMS

will change the shape and improve the performance of future off-road vehicles!

This DYNAPOWER Hydrostatic Transmission System uses a separate axial piston hydraulic pump and motor to produce torque as required up to 270 lb./ft. The variable pump provides an infinitely variable speed ratio and displaces a maximum of 4.8 cu. in./rev. The transmission is rated at a normal 60 HP but handles peak requirements up to 90 HP.

The word is out. DYNAPOWER *is* available. End-users even now are demanding operational benefits that only DYNAPOWER can provide.

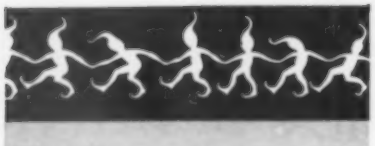
Number *one* on everyone's list is high torque at low rpm. Number *two* is Power-Absorption Braking which eliminates use of service brakes. Number *three* is infinitely variable speed in either direction without clutches or gear changers. Number *four* is faster, smoother response. Number *five* is simplified maintenance due to elimination of the conventional drive train.

Years ahead of its time, DYNAPOWER soon will make all conventionally equipped off-road vehicles years *behind*. Be sure you know all about DYNAPOWER before you freeze your new designs. Write today.

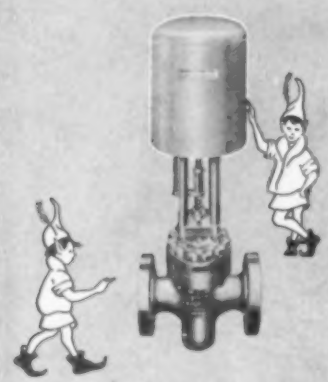
WATERTOWN DIVISION
THE NEW YORK AIR BRAKE COMPANY

124 STARBUCK AVENUE • WATERTOWN, N. Y.

Circle **124** on Reader Service Card



This is a pneumatic hydraulic servoactuator



. . . it is used for high power level positioning in pneumatic control systems. Here in one package is a complete actuator for valves and other loads, combining the high response capabilities of hydraulic operation with the flexibility of pneumatic control. Ask for Technical Bulletin 91441.

there's a lot of magic in B & F servo components.

Boonshaft and Fuchs Inc.

HATBORO INDUSTRIAL PARK • HATBORO • PA.

Circle **21** on Reader Service Card

AEROSPACE COMPONENT DATA

Self-Pressurizing Hydraulic Reservoir

Features: Provides positive pump supercharge pressure regardless of vehicle attitude. Reservoir's airless containers, operated by system pressure, offer freedom from foaming and fluid oxidation. Consists of two integral cylinders with a differential area type piston. Spring-loaded V-ring prevents air intake during cooling.

Specifications: One series covers capacity of 25 to 80 cu. in. Another series, 80 to 220 cu. in. For both series, temperature range is −65 F to 275 F, pressures from 1000 to 4000 psi. Nominal pressure ratio is 50:1, with others readily obtained by changing the high pressure piston. Bulletin A-5240 includes sketches and a table showing complete specifications and dimensions. *—Vickers Inc., Detroit.*

Circle **500** on Reader Service Card

Cartridge Flow Regulator

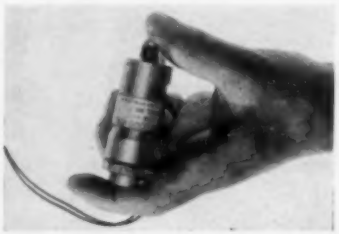
Features: Used in low flow hydraulic circuits. Maintains constant flow, regardless of variation in pressure, by opening to bypass flow to the reservoir.

Specifications: Has an adjustable regulated flow to 0.5 gpm and an adjustable total flow rate of 5% within a 600 to 2000 psi pressure range. Weighs 9 oz. Made of stainless steel and anodized aluminum. *—Fluid Regulators Corp., Painsville, Ohio.*

Circle **501** on Reader Service Card

Miniature Solenoid Valve

Features: Valve can be used for air or nitrogen, in stainless steel, for H_2O_2. Exceptionally fast response and high flow rate. Available as a 2-way, NC or 3-way valve. The 3-way unit can be NO, NC, or a selector valve by reversing ports. Typical flow capacity is equivalent to a ⅛" diameter, sharp-edged orifice. Balanced poppet design.



Specifications: Pressure to 3000 psi. Temperatures from −65 to 165 F. Voltage range from 18 to 30 vdc. Weight, 0.3 lb, with response time of 0.01 sec at 28 vdc. Size, 2-3/4" x 1-3/32" diameter.- *Kidde Aero-Space Div., Walter Kidde & Co., Inc., Belleville, J N. J.*

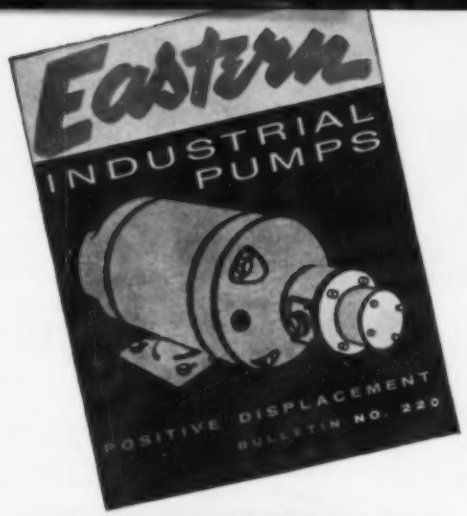
Circle **502** on Reader Service Card

Ball Valve Quick-Disconnect Couplings

Catalog describes quick-disconnect couplings for use on military and commercial aircraft, missiles, and test and ground servicing equipment. Coupling has positive locking action under severe vibration; low pressure drop due to straight-through flow; easy coupling and

Continued on page 114

Circle **38** →



EASTERN takes the gamble out of selecting

POSITIVE DISPLACEMENT PUMPS

If you have a performance requirement for pumps which can deliver a pulsation-free flow of non-lubricating liquids at pressures up to 200 psi on the gear type or rates up to 6 gallons per minute on the vane type, pick a winner from the big Eastern line.

For small volumes against relatively high pressures, the Eastern GW series gear pumps are a natural. In each pump, oversized bearings of impregnated graphite support a drive gear of stainless steel and an idler of special bronze material. These self-priming units require no lubrication and cannot contaminate the liquid being pumped.

For volumes from 1.5 to 6 gpm and pressures to 60 psi, you can't beat Eastern VW series vane pumps. These highly efficient units are designed around a cam-shaped pumping chamber assuring pulsation-free liquid flow. Vanes are held in positive contact with the pumping chamber at all times — and their positioning is independent of hydraulic pressure or centrifugal force. Composition carbon graphite bearings and vanes require no lubrication beyond that of the liquid being pumped.

All Eastern positive displacement pumps are close-coupled with motor or can be furnished less electric motor with belt stand for belt or coupling drive.

Don't make your points the hard way — play safe and write for Eastern's new Bulletin 220 on positive displacement pumps.

Other Eastern products:

- *hydraulic motors*
- *gear pumps*
- *centrifugal pumps*
- *aircraft pumps*

EASTERN INDUSTRIES PUMP DIVISION

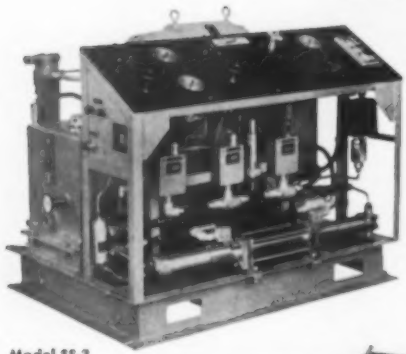
EASTERN INDUSTRIES INCORPORATED

Hamden, Connecticut

"OIL FREE"

GAS BOOSTER COMPRESSORS

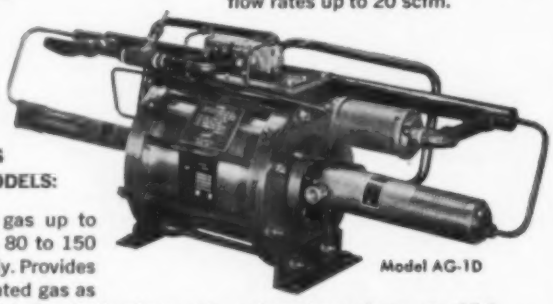
for Clean, Uncontaminated, HIGH PRESSURE GAS Requirements....



Model SS-3

SS SERIES
HYDRAULIC DRIVEN MODELS:

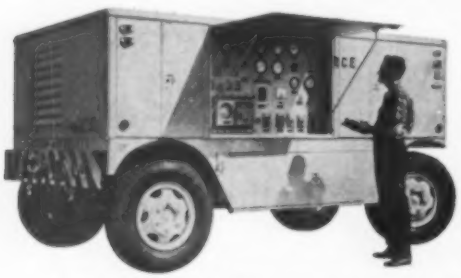
Boost bottled gas to pressures as high as 15,000 psig without contaminating the gas. Available in single stage or two stage models for compression ratios as high as 16:1. Suitable for use with nitrogen, helium (12:1 max. compression ratio), argon, dry air or any other inert gas. Available in 7½, 10 and 15 H.P. sizes for average flow rates up to 20 scfm.



Model AG-1D

AG SERIES
AIR DRIVEN MODELS:

Boost bottled gas up to 10,000 psig using 80 to 150 psig plant air supply. Provides same uncontaminated gas as SS Models. Available in single stage or two stage types for up to 16:1 compression ratio with flow rates as high as 14 scfm. Cooling water not required as driving air exhaust is used for gas intercooling and aftercooling.

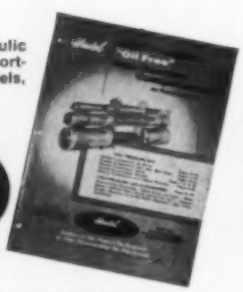


CUSTOM UNITS:

Designed and built for specific applications with drives up to 100 H.P. electric or diesel, in stationary or portable versions. Available in 1, 2, 3 or 4 stages of compression, for compression ratios as high as 120:1 with helium or any other inert gas.

Send for our new 24 page Catalog (No. M1).

It illustrates and describes our complete line of air driven, hydraulic driven, single stage and multi-stage models in stationary and portable versions. It also presents information on custom-built models, high pressure gas accessories and extra equipment available.



Haskel
ENGINEERING & SUPPLY CO.

1236 SO. CENTRAL AVENUE • GLENDALE 4, CALIFORNIA

Circle **52** on Reader Service Card

AEROSPACE COMPONENT DATA

uncoupling; self-sealing when disengaged; and can be coupled and uncoupled under pressure. Ordering information, envelope dimen-

sions, style of end fittings, and flow-pressure drop graphs for aluminum or stainless steel couplings in sizes from ¼" to 2" and pressures to 3000 psi.—*The Weatherhead Co., Special Products Div., Cleveland.*

Circle **503** on Reader Service Card

All-Metal Union Fitting

Features: All-metal, stainless steel tube and pipe union fitting seals without leakage on applications

with pressures to 16,000 psi and temperatures from −450 F to 1500 F. For pneumatic, hydraulic, vacuum, or fuel lines. Bulletin 804 gives engineering details. Sizes from ¼" to 1" tube OD. An exploded view of the fitting is shown. **Designation:** Conoseal Union Fitting.—*Marman Division, Aeroquip Corp., Los Angeles.*

Circle **504** on Reader Service Card

Cryogenic Liquid Demand Regulator

Features: Regulator valve regulates flow of LOX and LN_2 from a gas differential pressure signal. Has four ports: liquid inlet and outlet ports, reference pressure gas port, and ambient gas port. Regulator operates on inlet pressures to 40 psig. Zero internal leakage to 30

Continued on page 116

HOKE Flow Sheet 4

HOKE REPORTS ON FLUID CONTROL

HOW TO SWITCH PRESSURES IN MID-STREAM

PRESSURE BY THE POUND . . . no matter how thin you slice it!

One trouble with doing something better is that it's hard to stop. This time, we've come up with a new line of pressure regulators. We made them for the technically oriented who have developed high standards and for the penurious purchaser who wants something for (almost) nothing.

One, tagged as the 680 Series, is a highly stable single stage regulator with something for just about everyone. The core of this regulator is its control accuracy of 2% at flows to 2000 SCFH. Two models are available. One delivers 0 to 40 psi and the other 0 to 140 psi and both can handle inlet pressures up to 3000 psi. Use them on any gas compatible with 2024-T4 aluminum alloy, neoprene, polyurethane and Buna-N.

If what we've said sounds good so far, but still won't solve your problems, read on.

We've built a regulator specially for corrosive gases and atmospheres. Available in either all monel or all stainless steel construction, we call it the 640 Series. Spec sheets on this can be had by marking an "X" below.

If you "X" the next box, you'll get a package of useful information on a special regulator that will handle delivery pressures up to 4500 psi with very high control accuracy. This is a 2 stage spring and dome loaded regulator and we claim that a 50% change in inlet pressure will not change the delivery pressure more than 2%. Operation is simplicity itself. For no particular reason, we call this the 920 Series.

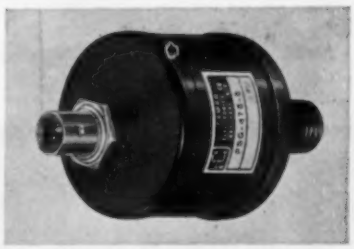
Skeptics should send for all of this information.

For reasons now hidden by the veil of tradition, no one has ever attempted to scrunch a pressure switch to its proper proportions—that is, until now. With sales getting bigger from making things smaller, we decided that this was the path to profit. Ergo; the new Hoke Pamar pressure switch.

This isn't just a case of arrested development, but something entirely new. The scrunching process necessitated less parts, so conventional connecting linkages were the first to go. The direct result: a switch with only one moving part—nothing to wear and upset the actuation setting.

The ordinary bellows was out of the question, so we used a Ni Span C capsular type sensing element. Out of this came such things as high repeatability, minimum hysteresis and drift, maximum temperature stability, and a dead-band of minor significance.

The whole assembly measures less than 2 inches from tip to terminals, and weighs short of one ounce. Despite these diminutive dimensions, it is capable of handling working pressures to 500 psi with a repeatable accuracy of ±0.5%. Electrically, it sports a snap-action switch that will conduct a current of up to 7 amps to a variety of connectors – AN, cabled leads, solder terminals, or whatever you want. Interested in pressure switches for explosive atmospheres? Specify the explosion-proof model.



A special low pressure switch (0 to 7 psi) defies competition with a dead band of 2" of water!

If what you're looking for in a pressure switch seems impossible to find (even with the wonders we've described here), we'd like to hear about it. We thrive on doing what others shrink from, and will build a switch to your specs. Write and tell us your problem.

We could go on, but that wouldn't leave us with the usual advertising "hooker". We want to hear from you. In return, we'll send you the rest of the story.

WHAT'S NEW FROM HOKE?

Lots of things have been happening at Hoke. To be sure you're up to date on these developments in fluid control see your nearest distributor. He'll have something new for you every other month this year.

Hoke's Performance Guarantee—*Every Valve Leak-Tested!*

HOKE INCORPORATED
87 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

- ☐ Pamar Pressure Switches
- ☐ 680 Series Regulator
- ☐ 640 Series Regulator
- ☐ 920 Series Regulator
- ☐ "What's New"

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

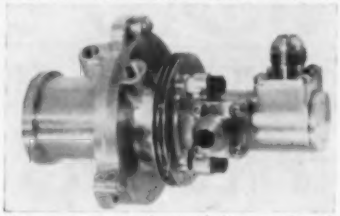
CITY_____ STATE_____

SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE

AEROSPACE COMPONENT DATA

psig inlet pressure, whether the cryogenic fluid is liquid or gas. The valve operates at demand pressures of 2 to 4 psig ± 3%. Demand and ambient pressures may be referenced remotely from the regulator.

Specifications: Liquid inlet and outlet port size, ½" tube fittings. Gas reference port size, ¼" tube fittings. Weight, 1.2 lb. Meets vibration requirements of MIL-E-5272A. Valve and valve seat of



stainless steel. Liquid flow rate at 20 psi, 40 lb/min.

Designation: Model F7067700. Type I, as above. Type II, with solenoid on-off override over the reference pressure.—*The Firewel Co., Inc., subsidiary of The Aro Equipment Corp., Buffalo, N.Y.*

Circle **505** on Reader Service Card

High Pressure Polymer Seal

Features: Spring-loaded, self-conforming polymer seal for reciprocating and low speed, rotary shafts. The seal, for liquids and gases, combines a polymer and spring steel. Polymer gasket deforms under spring load and constant pressure toward the shaft and produces a tight seal. Polymer deformation is always toward the shaft and is self-adjusting for creep and wear.

Specifications: For temperatures from −320 F to 500 F and pressures to 10,000 psi.—*Del Manufacturing Div., Arrowhead-Puritas Waters, Inc., Los Angeles.*

Circle **506** on Reader Service Card

Low Torque Swivel Joints

Features: Permanent type swivel for use with many types of fuels and solvents and other liquids and gases. Uses fluorinated polyethylene seals and stainless steel exteriors. All joints assembled and tested in a new, LOX clean room.

Specifications: Low torques, ranging from 16 lb-in. for a ¾" joint to 240 lb-in. for a 2" LOX joint, are maintained through a temperature range from −420 to 275 F, with momentary exposure to 5000 F. Operating pressures 6000 psi, with proof pressure twice operating pressure.—*Consolidated Controls Corp., Inglewood, Calif.*

Circle **507** on Reader Service Card

High Pressure Air Compressor

Features: Small, portable compressor for many flight line operations. Data Sheet No. 26 includes photographs, specifications, and the diagram of the pneumatic system.

Continued on page 118

BHEW
Hydraulic Cylinders

- Basic Designs
- Specific Adaptations
- Superior Quality
- Application Engineering

BHEW'S HOLLOW ROD CYLINDERS are two piece tubular rods that allow oil to flow through the rod in two separate channels to operate double-acting cylinders. You benefit from this application because the cylinder barrel is plain without port connections and the rod is anchored in a stationary position. The barrel is the reciprocating member.

• Eliminates hydraulic line connections to the cylinder barrel. • Especially successful for boom extenders, out-riggers, etc. • Hollow rod cylinders are partially constructed around standard components.

Production parts save you money, do the job better! BHEW basic cylinders can easily be modified to fit your *specific* product applications. You benefit from production economies; you get custom-built cylinders.

Let's discuss your design and application problems —

FREE!
Write today for Hydraulic Cylinder Engineering Reference Data — 78 dimensional basic designs for general — and special-purpose double-acting cylinders. SAVE TIME.

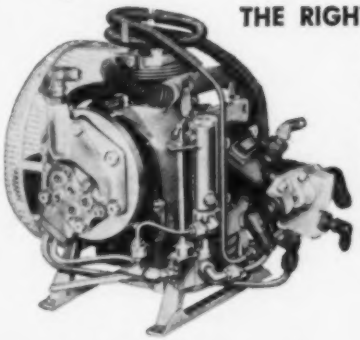
BENTON HARBOR ENGINEERING WORKS, INC.
622 Langley Avenue St. Joseph, Michigan

Circle **20** on Reader Service Card

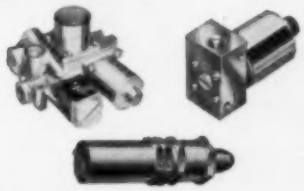
Circle **75** on Reader Service Card

MC
high quality costs less

THE RIGHT START PAYS IN THE END



MC customers have learned that our thoroughness in all steps—designing, scheduling, planning, manufacturing, controlling, testing—means real economy in aircraft and missiles. We invite your inquiries and your visits—our well established and well equipped facility is efficient and flexible—ready to serve you!



We can solve your fluid system problems, supply subsystems and many types of valves; also pumps, dehydrators, etc.

WRITE, WIRE, or PHONE for data, quotations, and services.

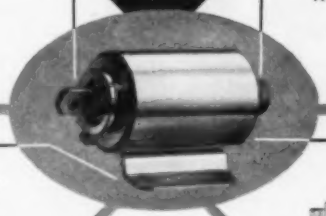
M. C. MANUFACTURING COMPANY
LAKE ORION, MICHIGAN • PHONE: MYrtle 2-2711

AIRCRAFT • MISSILE • ORDNANCE

SOLENOIDS

STANDARD DESIGNS with CUSTOM FEATURES

ARMATURE EXTENSION
EXTERNAL THREAD
INTERNAL THREAD
CLEVICE
LEADS or CONNECTORS
LEADS
RECEPTACLE
TERMINALS
MOUNTING
BASE
THREADS
FLANGE
¾ TO 2" DIAMETER



These Standard Solenoid features offer a quick delivery at low cost. Operating characteristics are flexible to the design requirements. Units can be furnished for high or low temperature, continuous or intermittent duty.

• **Write for a Design Data Book and Catalog**

MANUFACTURING DIVISION OF
KOONTZ WAGNER ELECTRIC COMPANY INCORPORATED
516 N. MICHIGAN ST.
SOUTH BEND, INDIANA

Circle **65** on Reader Service Card

The *Mastergauge* SERIES

and companion "Master-test" group for extreme services requiring the ultimate in accuracy and stamina.

Right *Quality* SERIES

also for tough services, but less severe than the conditions served by the "Mastergauge"

Gauge *Standard* SERIES

for the general run of gauge services. Marsh quality and accuracy at a moderate price.

for every need

Within these three comprehensive Marsh groups you have the world's widest (yes, and wisest) selection of pressure gauges. These groups of gauges are not *grades* ... they are *kinds* ... the MARSH kind ... which means that each gauge, within the scope of its rated use, is the BEST of its kind!

Pick the right Marsh Gauge and you have the best answer to your gauge problem.

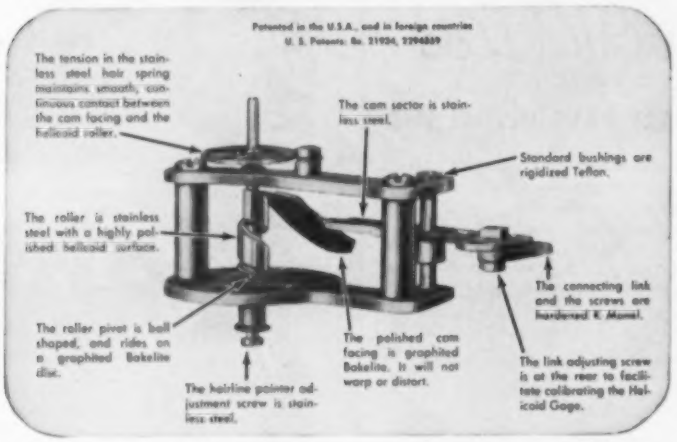
Ask for latest data

MARSH INSTRUMENT COMPANY
Division of Colorado Oil and Gas Corporation • Dept. 19, Skokie, Ill., Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta • Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas • Eastern Seaboard Warehouse: Marsh Instrument Company, 1289 Anderson Ave., Fort Lee, N. J.

MARSH

GAUGES • THERMOMETERS
VALVES

Circle **77** on Reader Service Card


Patented in the U.S.A., and in foreign countries
U. S. Patents: No. 2192, 2294859
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is stainless steel.
Standard bushings are rigidized Teflon.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides... *Sustained Accuracy... on the toughest jobs*

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

Distributed in Canada by
Upton, Bradeen & James, Ltd.
Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Edmonton, Vancouver

WRITE for details

Ask for Catalog DH-65

HELICOID GAGES

Helicoid Gage Division • American Chain & Cable Company, Inc.
929-H Connecticut Ave., Bridgeport 2, Conn.

Circle **53** on Reader Service Card

AEROSPACE COMPONENT DATA

Specifications: Has a capacity of 4 scfm and delivery pressures to 3100 psi pure, dry air. Meets MIL-C-25989.—*The Cornelius Company, Minneapolis.*

Circle **508** on Reader Service Card

Solenoids

Features: Standard internal features, custom exteriors. Short strokes. Base or end mountings. Leads or connectors for electrical termination. Standardized parts.
Specifications: For 28 vdc and other dc applications. Sizes from miniature to 2" dia, and over.—*Koontz Wagner Electric Co., Inc., South Bend.*

Circle **509** on Reader Service Card

You can win up to $500 by entering the
1961 FLUID POWER PRIZE PAPER CONTEST
For details circle 220 on reader service card

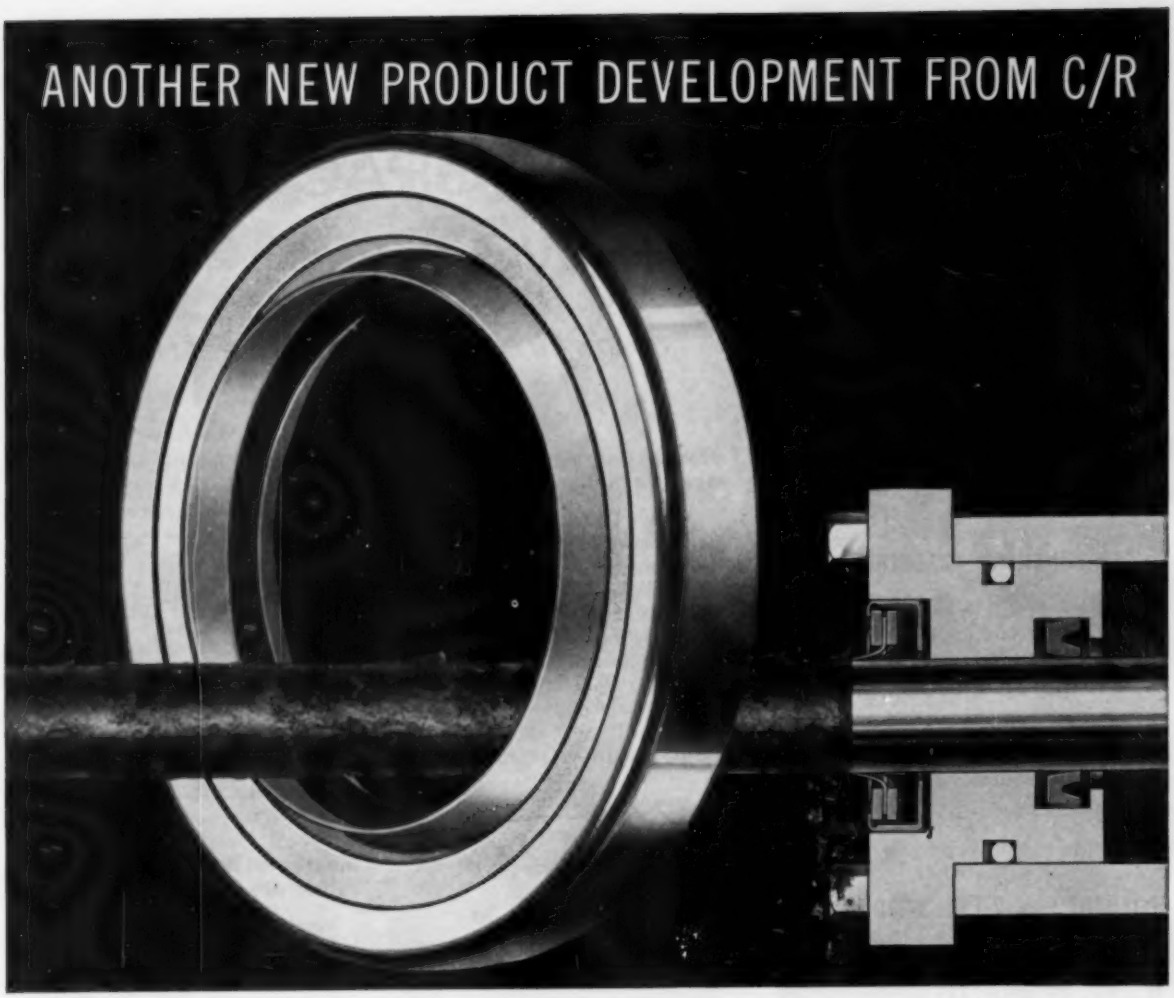
D-C Pressure Transducer

Features: Small, low power, variable reluctance, d-c pressure transducer has excellent linearity, low hysteresis, continuous resolution, and immunity to temperature, acceleration and vibration effects. For pressures to 5000 psi. Weighs 5 oz. Requires 3 ma at 28 vdc for 0- to 5-vdc output. No amplifiers are used.

Designation: Type P2-3076.—*Daystrom-Wiancko Engineering Co., Pasadena, Calif.* ▼▼▼

Circle **510** on Reader Service Card

ANOTHER NEW PRODUCT DEVELOPMENT FROM C/R



New Wiper-Scraper Seal for Cylinders

Scrapes off ice, mud, tar – wipes off water, dust, other contaminants

Now, you can effectively exclude dirt and other contaminants from hydraulic cylinders under the most severe field conditions. One compact unit, the C/R SC Wiper-Scraper Seal does the job. Formerly, a separate rod scraper had to be installed in front of the ordinary wiper seal. The special machining necessary, plus the scraper ring, and retaining ring made this an expensive installation.

Chicago Rawhide's SC Wiper-Scraper Seal combines a spring brass scraper and synthetic rubber wiping member in one steel shell. The I.D. of the scraper is slightly under shaft size to provide a snug fit that will remove tar or frozen mud, but it has sufficient play within the shell to tolerate any off-center conditions of the rod such as caused by bearing "bore-slop." The cost is much lower than any other combination of scraper and wiper. "Design-in" cost is low, assembly simple. Most important is the performance contribution to the cylinder. The additional value of longer packing life and increased operating dependability with the SC Wiper-Scraper Seal will far outweigh the nominal cost.

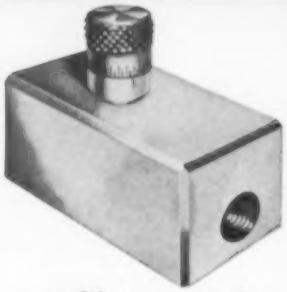
For complete information, specifications and standard sizes, write for your copy of C/R's new Bulletin SC-100

CHICAGO RAWHIDE MANUFACTURING COMPANY

OIL SEAL DIVISION: 1203 ELSTON AVENUE • CHICAGO 22, ILLINOIS
Offices in 55 principal cities. See your telephone book.
In Canada: Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario
Export Sales: Geon International Corp., Great Neck, New York
C/R Products: C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts
Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears.

C/R

for positive flow control . . .
POW-R-TROL
SPEED CONTROL VALVES



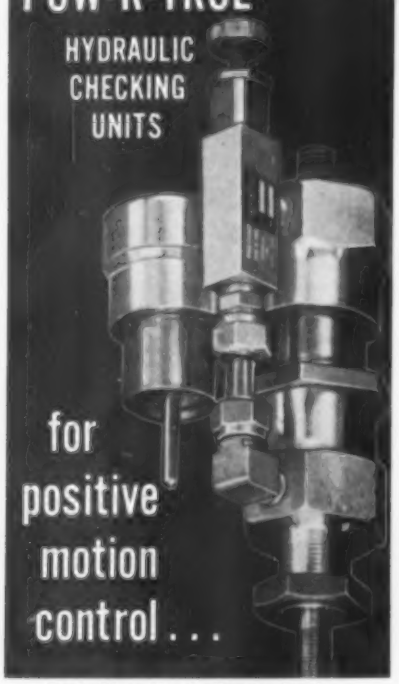
sensitive • accurate
dependable • economical

Available with ¼" to 1" ports, pressure ranges up to 5000 psi, with or without micrometer adjustment, and with male or female dry seal pipe-threads. Meet all J.I.C. and AN Specifications.

Write for complete details.

POKORNY POW-R-TROL PRODUCTS, Inc
10643 Memphis Rd. • Cleveland 9, Ohio

POW-R-TROL
HYDRAULIC CHECKING UNITS



for positive motion control . . .

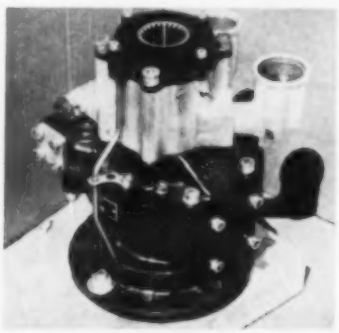
Circle 96 on Reader Service Card

AEROSPACE NEWS

from the fluid power field

Hound Dog pump contract goes to Kellogg

A $400,000 contract for hydraulic pumps for the GAM 77 Hound Dog missile has been awarded to the Kellogg Division of American Brake Shoe Co. by North American Aviation, prime contractor on the air-to-ground missile. The pump will deliver 39 hp to operate the missile's dynamic flight control surfaces. These single-stage, axial-piston pumps are variable-delivery, pressure-compensated, hydraulically balanced internally, and weigh

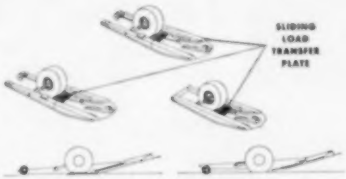


19 lb. Nominal rating is 6 gpm at 3000 psi and 1500 rpm. On the Hound Dog, however, these pumps will deliver full flow at 5000 rpm, and will operate at speeds to 7300 rpm.

FluiDyne announces hydraulic aircraft skis

A single hydraulic system actuates load transfer plates to convert tri-cycle aircraft from wheels to skis. The pilot in the cockpit selects either position anytime during flight, taxiing, or when parked. For ski position, a moveable section of the ski bottom slides under each of the three tires. Each tire rests entirely on the ski bottom.

These are the first skis for tri-cycle planes with full wheel to ski conversion, including the nose wheel. FluiDyne Engineering Corp.,



Minneapolis, announced that the skis meet the requirements of the FAA and the Canadian DOT.

Monterey Research Lab is subsidiary of Research, Inc.

Monterey Research Laboratory, Inc. recently became a subsidiary of Research, Inc. of Minnesota. The Monterey, Calif. company specializes in research and development, and limited production of electro-hydraulic, pneumatic, and compressible fluid devices and other systems.

Airsupply-Aero moves engineering office

The Indianapolis office of Airsupply-Aero Engineering Co., div. of Garrett Corp., has been moved to 2441 N. Meridian St. The office, covering Cincinnati, Indiana and Kentucky, acts as midwest district headquarters. The company provides engineering sales service for firms in defense and specialized industries.

Cornelius increases sales staff

The Aero Division of The Cornelius Company, Minneapolis, appointed two resident sales engineers and named an assistant to

Continued on page 123

Circle 7 →

What the affiliation of Rochester Manufacturing Co. with American-Standard® means to you

Perhaps you read the story in the WALL STREET JOURNAL. "American Radiator and Standard Sanitary Corp. . . . has acquired Rochester Manufacturing Co., maker of gauges and instruments. Rochester Manufacturing will operate as a part of American-Standard Controls Division."

There was more. But what is of immediate concern to you is: what does this consolidation of two great names in the field of instrumentation mean to the hydraulics and pneumatic fields?

It means expansion of Rochester Instruments' research and development program, reflecting broader product lines.

It means that the scope of the Rochester operation will be increased to serve industry more effectively.

It means that the complete facilities and capabilities of the American-Standard Controls Division are at your disposal as Rochester engineers work with you.

In short, it means *growth* . . . greater resources and development of important new products to take their place beside Rochester thermometers and pressure gauges—and Detroit TyniSwitches®, Pressure and Temperature controls, Vernatherm thermostats, and Norwood Strain Gauge Pressure Pickup.

We look forward to the opportunity, as we always have, to help you keep pace with America's growth and development, but now we meet the challenge with a greater abundance of resources.

The familiar RMC trademark, symbol of quality instrumentation, has undergone a design change as a result of the affiliation of Rochester Manufacturing Co. with American-Standard. Here *(right)* is the new trademark for Rochester Instruments, and this is our new name: American-Standard Controls Division, ROCHESTER INSTRUMENT PLANT, 209 Rockwood Street, Rochester 10, N. Y. (also ROCHESTER INSTRUMENTS, 1401-C South Shamrock Ave., Monrovia, Calif.)

AMERICAN-Standard
CONTROLS DIVISION

Rochester Thermometers

Rochester Pressure Gauges

NORWOOD Strain Gauge Pressure Pickup (to 100,000 psi.)

DETROIT Vernatherm

All here . . .

components that satisfy

all pressure/flow system needs

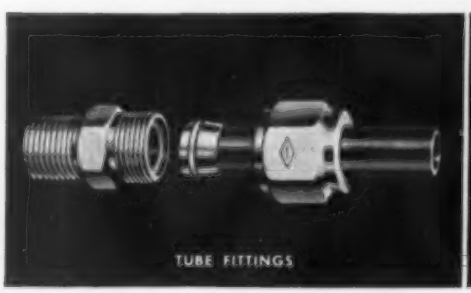
IMPERIAL EASTMAN

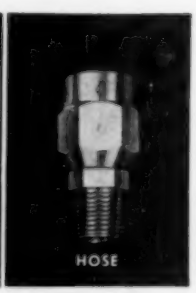
Now together, Imperial-Eastman meets all your hydraulic-pneumatic-flow component needs: tube fittings, valves, couplings, flexible and rigid hydraulic lines, thermoplastic tubing and tubing tools.

This *engineered* line gives you the exact product for every type of service condition—and the tools to make sure your assemblies are absolutely right.

For added satisfaction at your point of order, Imperial-Eastman products are available through highest caliber distributors.

For complete information, write for Catalog No. 101.





IMPERIAL EASTMAN

Imperial-Eastman Corporation General Offices: 6300 West Howard Street, Chicago 48, Illinois

In Canada: Imperial-Eastman Corporation (Canada) Ltd., Barrie, Ontario

Circle 60 on Reader Service Card

Only

IMPERIAL EASTMAN

offers a line as complete as this

When we say *your most complete line* of pressure flow system components for all hydraulic, pneumatic, instrumentation and other applications—here's what we mean:

TUBE FITTINGS OF EVERY TYPE AND SIZE—FOR ALL PRESSURES, TEMPERATURES
- Hi-Seal® Butt Joint Fittings, Braze-Seal Hi-Pressure, Hi-Duty, 37° Flare, 45° Flare, Flareless, Flex, Compression, Inverted Flare, Threaded Sleeve and Plastic Tubing Fittings.

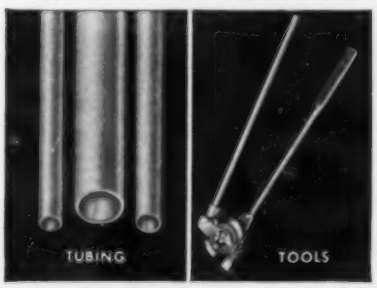
FLUID CONTROL VALVES
- Needle, Toggle, Diaphragm, Plug, Blow-Down and Kwik-Connect Types for pressures up to 5000 psi.

HOSE AND COUPLINGS
- Medium-Pressure Hose and Tube Assemblies, Couplings and Fittings for One-Wire Braid Hose
- High-Pressure Hose and Tube Assemblies, Couplings and Fittings for Multiple-Wire Braid Hose
- Low-Pressure Hose and Tube Assemblies, Couplings and Fittings for Fabric Braid Hose
- All Synthetic—for Pressures up to 3000 Lb.
- Adapter Unions, Adapters and Tube Fittings

TUBING
- Plastic and Thermoplastic

TUBING TOOLS
- Cutting, Flaring, Bending, Reaming, Swaging, Pinch-off, Refacing Tools
- Service Aids

No doubt about it now—see your Imperial-Eastman distributor *first* for all hydraulic-pneumatic-flow system components.



IMPERIAL EASTMAN

Chicago 48, Illinois

AEROSPACE NEWS

from the fluid power field

its sales manager. Chester Yaros was named resident field sales engineer in the west coast area; and H. Richard Callaway, in the east-

Yaros

Callaway

ern U. S. Richard Aronson has been appointed assistant to the sales manager. Mr. Aronson has been with Cornelius for eight years.

Test stand for aircraft components developed by Aero-Test Equipment

A hydraulic test stand for functional control and operational testing of aircraft, mobile, and industrial components has been developed by Aero-Test Equipment Co., Inc., Dallas. The stand, designated Series 176, has a single main system with capacities of 5 gpm at 5000 psi and 10 gpm at 3000 psi; a static system measuring to 10,000 psi; and two auxiliary, single-line, static test systems measuring to 500 psi and 1000 psi. The stand uses MIL-H-5606 fluid, and has a full-length stainless steel sump. A heat exchanger with temperature control is available. The stand, without the exchanger will operate from 0 to 150 F.

Pall appoints assistant chief engineers and sales manager

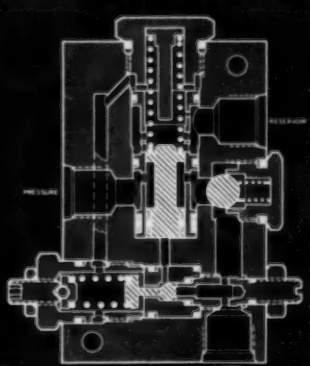
Three assistant chief engineers have been appointed at Aircraft Porous Media, Inc., a subsidiary of Pall Corporation, Glen Cove, N. Y. At the same time a sales manager for Pall's Micro Metallic Division was also appointed. All positions are new and have been created to cover the expanded areas of corporate activities.

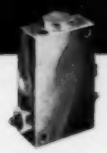
The three new assistant chief engineers are: Leslie Seawert, S.

Continued on next page

ONLY UNLOADING VALVE
with adjustable differential

- Get 5% to 20% Differential — set unload and reload pressures independently
- Simplify Piping — available with integral check
- Complete Loading and Unloading Assured — positive snap action

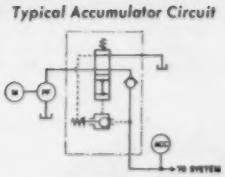




- Available from stock for pressures to 3,000 psi
- Use in accumulator and Hi-Lo circuits—also to vent high capacity pilot operated relief valves
- Sizes — ⅜" & ½" Pipe and SAE ports

Write for detailed literature

Typical Accumulator Circuit



Fluid Controls, inc.

Member of National Fluid Power Association

Manufacturers of Hydraulic Valves and Devices

Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

P.O. BOX 186 • MENTOR, OHIO

Circle **41** on Reader Service Card

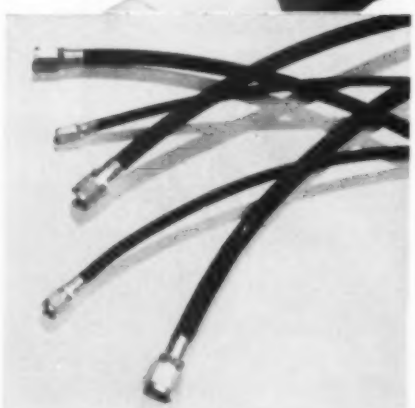
THE HOSE WITH BENDING POWER

Pressure hose that resists kinking can save money in installation and flex life—and increase reliability!

NYLAFLOW hose features an all bonded construction with the braid chemically bonded to the inner-core and the abrasion resistant nylon cover chemically bonded to the braid. Thus the hose can be bent to a considerably tighter radius before kinking occurs.

New NYLAFLOW® Pressure Hose* has half the wall thickness and weighs only 1/5 as much as wire braided rubber of equivalent burst strength . . . yet gives you exceptional resistance to flex and vibrational fatigue.

NYLAFLOW hose takes delight in resisting the effects of hydraulic fluids, caustics and almost all organic solvents. NYLAFLOW's freon permeability is approximately 1/10 that of rubber hose. It is an excellent non-conductor for use around high voltage lines.



Other important features

Odorless, non-toxic, non-corrosive, fungus resistant and will not embrittle in storage. Temperature range (—40°F to 225°F). NYLAFLOW hose can be permanently heat-formed to small, stress-free bend radii, saves lengths required, improves performance and appearance.

Burst pressure range of 5,000 to 12,000 psi; available in long continuous lengths in standard inside diameters of ⅛" through ¼". Hose meets burst requirements of SAE specification 100-R-1 and 100-R-5. Compact, lightweight, reusable fittings and assemblies also available.

Tubing also available

NYLAFLOW Pressure Tubing in sizes up to ⅜" O.D., with burst pressure ratings of 1,000 and 2,500 psi, is ideal for lower pressure requirements. It is also flexible for easy installation and can be attached with standard flare or compression fittings designed for metallic tubing.

Full details and illustrated brochures now available on new NYLAFLOW Pressure Hose and Pressure Tubing. Write today!

* Patents applied for

POLYPENCO® *industrial plastics*

The Polymer Corporation of Pennsylvania

Reading, Penna.
EXPORT: Polypenco, Inc.
Reading, Pa., U.S.A.

Circle **97** on Reader Service Card

AEROSPACE NEWS

from the fluid power field

R. Jupiter, and Marcel Verrando; all formerly group engineers responsible for specialized areas of filter development. The new sales manager is Stanley Sakol, formerly assistant sales manager. All men are graduate engineers experienced in their respective fields.

You can win up to $500 by entering the 1961 FLUID POWER PRIZE PAPER CONTEST

For details circle 220 on reader service card

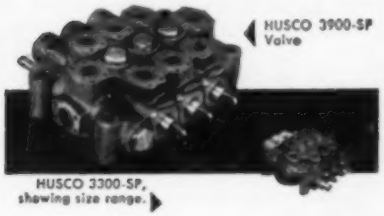
United Control Systems completes canopy test fixture

Test fixture simulates ground and flight conditions for production testing of canopy actuators used on F-106A Jet Interceptor and F-106B Trainer. Fixture consists of pump stand, test carriage, and control console. Fixture provides programmed resistance to the actuators. To meet requirements that the load on the actuator change with position, a bi-directional hydraulic cylinder is coupled to the linear motion, electric motor-driven actuator.

The cylinder is completely restrained to prevent hunting, which occurred when the load passed through zero when changing from tension to compression. Maximum stroke is 48", and thrust varies from 100 to 3000 lb. Console includes all necessary interlocking and sequence components, so most of the testing is automatic. Manufacturer is United Controls Systems, Inc., Dayton, Ohio. ▼▼▼

Circle **58** on Reader Service Card

Why HUSCO HYDRAULIC MULTI-PLUNGER VALVES *fit a greater range of control needs . . .*



HUSCO 3900-SP Valve

HUSCO 3300-SP, showing size range.

- **Choice of FIVE Basic Model Sizes — over 120 standard valves for unlimited modifications to specific needs.**
- **Control up to SIX Cylinders, single or double acting.**
- **Up to FOUR Standard Control Positions — raise, lower, float and neutral.**
- **Available with Flange or Standard Mounting (3900 Valves only).**
- **Accurately Rated Capacities from 3 to 185 G.P.M. at 22 f.p.s. velocity.**

These are only a few reasons why HUSCO Valves are more flexible in adaptation to your needs, more efficient in power-saving control.

Write for detailed specifications on HUSCO 3300-SP and complete catalog "Husco's House of Ideas" — or engineering aid on your hydraulic control needs.

HYDRAULIC UNIT SPECIALTIES CO.

PUMPS • VALVES • CYLINDERS

P. O. Box 257-A, Waukesha, Wisconsin

West Coast Representatives

EASTMAN PACIFIC CO., Los Angeles, Calif.

ROY BOBBS AIR-DRAULIC CO., Portland, Ore.

Circle **11** on Reader Service Card

"CONSULT THE AUTHORITY!"

Raymond Atchley Division

AMERICAN BRAKE SHOE CO.

GSE SERVO SYSTEMS

INDUSTRIAL SERVO SYSTEMS

AERO/SPACE SERVO SYSTEMS

Since its inception, Raymond Atchley has developed many servo systems for both the military and industry . . . from missile controls to industrial automation. Years of experience in servo components and systems has been responsible for numerous and unique control systems. Atchley's research and development staff is currently investigating several new, promising control techniques for both aircraft and space vehicles. If it's a system involving electronic, hydraulic or pneumatic servo controls, consult Atchley.

ATCHLEY'S *Jet-Pipe* SERVOVALVE

. . . operates despite contamination

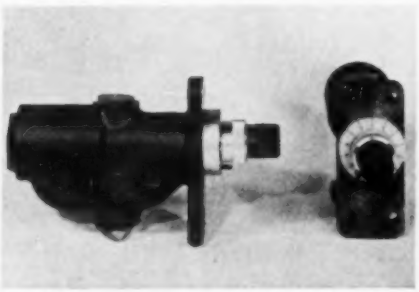
Atchley's servovalve is famous for continued performance . . . at unprecedented levels of contamination up to 25 times normal rate. Its exclusive Jet-Pipe feature makes this possible. Contamination is removed as a factor in reliability. Available in flows, one to 60 gpm; miniature models up to 1¼ gpm.

Raymond Atchley Division

AMERICAN BRAKE SHOE COMPANY

2339 COTNER AVENUE, LOS ANGELES 64, CALIF.

NEW pressure compensated LOW FLOW rate regulator



controls Flow as low as 2 cubic inches per minute.

Accuracy of ±10% over a pressure differential of 1000 psi at 2 CIPM.

Especially good for machine tools, air-oil cylinders, jet engine starters, or wherever a low rate of oil or fuel flow must be controlled accurately.

Designed for panel mounting on test stands or bracked mounted in pipe lines.

Built-in check valve provides free flow in reverse direction.

Adjustable between 2 and 90 cubic inches per minute.

Write for illustrated circular with blueprint.

FLUID POWER ACCESSORIES, INC.

P. O. Box 64, 2051 Railroad Avenue • Glenview, Illinois

Circle **42** on Reader Service Card

NEW! KEPNER Kepsel

Cartridge type valve insert

The Check Valve that cuts costs of Design and Installation 75% and more!

- Leak Proof—At All Pressures
- Low Pressure Drop at Full Flow
- Eliminates All Threaded Connections
- Eliminates Expensive Machining

Small in size—big in capacity—simple to install—the KEPNER Kepsel Cartridge Type Check Valve is designed for positive performance. Eliminates expensive machining, finishing of fine, close tolerances, metal surfaces—dirt can't hurt it.

Write for complete technical data

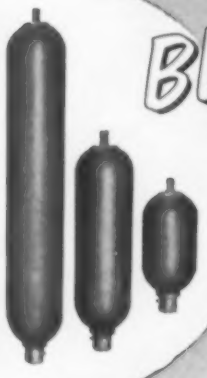
*Patent Applied For

KEPNER PRODUCTS COMPANY

7321 West 59th Street Summit, Illinois

Circle **64** on Reader Service Card

GREER Headquarters for ACCUMULATORS



BLADDER
ACCUMULATORS

OVER 100,000 SOLD, some in continuous use for more than 15 years — proof of superior reliability, safety and dependability in a wide variety of circuit applications. Standard models available in two operating ranges: 0-3000 psi and 0-6000 psi, from 1.5 cu. in. to 2080 cu. in. capacities*.
WRITE FOR CATALOG PR-200.

PISTON
ACCUMULATORS

A NEW LINE of piston accumulators for standard industrial performance. Features extra built-in safety. Available for 3000 psi operation in nine sizes from 10 cu. in. to 2250 cu. in.capacities.
WRITE FOR BULLETIN IPA-1.

SPECIAL
ACCUMULATORS

FOR AIRCRAFT, MISSILE or industrial applications requiring bladder accumulators in special shapes, sizes or operating characteristics. Standard bladder-type transfer-barrier accumulators available in two pressure ranges: 0-3000 psi an 0-6000 psi in a variety of sizes*. Contact your Greer representative with your requirements.

*U.S. Licenses under Greer Patents

GREER HYDRAULICS, INC.
Main Office & Plant: 5930 W. Jefferson Blvd., Los Angeles 16, Calif.
Eastern Sales Office: 496 Grand Blvd., Westbury, N. Y.
Midwest Sales Office: 7331 No. Ridgeway Ave., Skokie, Illinois
Distributors & Representatives in all principal cities

Circle 130 on Reader Service Card

FLUID POWER PATENTS

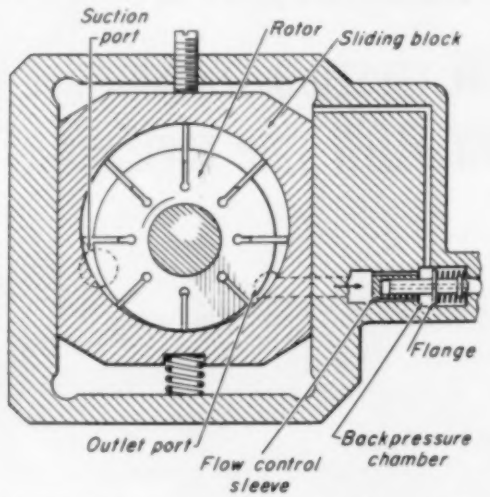
Backpressure Valve Pressure Compensates Pump

Designed for mobile equipment, this pump delivers a fixed quantity of fluid with varying input shaft speed. It maintains a constant output by varying displacement as the pump's drive speed changes.

It is a vane type pump. As drive speed changes, flow is held constant by moving the sliding block in which the vanes rotate. As speed increases, eccentricity between the rotor and the sliding block decreases, reducing pump displacement.

• **Operation**—A coil spring holds the sliding block against an adjustable stop in its maximum displacement position. As the rotor turns clockwise, fluid enters the pump through the suction port and is discharged through the outlet port.

Fluid leaving the pump flows through a restrictor valve. The valve has a chamber (backpressure chamber) in which pressure increases in direction relation to flow through the valve. The backpressure is ported to the chamber above the pump's sliding block. As backpressure increases, pump displacement decreases.



• **Valve Operation**—Fluid leaving the pump flows into the backpressure chamber through an orifice formed by the outside diameter of the flow control sleeve and the inside diameter of the valve cavity. Fluid flows from the backpressure chamber around the outside diameter of a flow control flange to the system. As flow around the outside diameter of the flow control flange increases, pressure in the backpressure chamber increases. This pressure is applied to the top of the sliding block. The block moves down, decreasing pump displacement.

When flow reaches the maximum setting, pressure

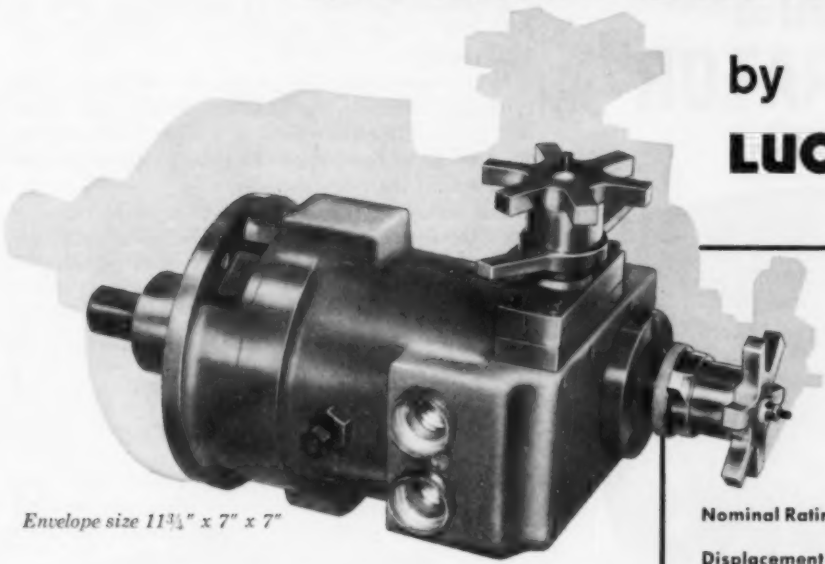
Continued on page 128

Light-weight, compact and extremely versatile — the reliable

NEW IP 250 INDUSTRIAL HYDRAULIC PUMP

by

LUCAS-ROTAX



Envelope size 11¾" x 7" x 7"

One of the complete new range of quality built hydraulic pumps and motors by Lucas-Rotax, the IP 250 offers many technical advances and advantages. **• Small size • Low weight • Variable volume • Low noise level at higher operating speeds • Low cost • High efficiency • Fitted with integral or remote pressure compensator as standard equipment.**

For further information, contact the agent or office nearest you today, or write for technical literature.

PUMP DETAIL

	Basic Pump Fixed Stroke
Nominal Rating at 3,600 r.p.m.	18 G.P.M.
Displacement (cub. ins./rev.)	1.157
Working pressure up to	5000
(lbs./sq. in.) (continuous)	3000
Speed up to	4000
(r.p.m.) (continuous)	3600
Input h.p. at 1,000 r.p.m. and 1,000 lb. per sq. in. differential	3.32
Weight	29 lbs.
Operating Temperature, °F	−40 to 200
Direction of Rotation	Either
Pressure Compensator Range	500-5000 p.s.i.

a product of creative engineering by

For further information contact U.S. Representative:
JULIUS KENDALL,
Kenaff Corporation,
320 Washington Street
Brookline 47, Mass.
LOngwood 6-0378

LUCAS-ROTAX
LIMITED, TORONTO

A member of the Lucas organization
WITH OFFICES AND SERVICE DEPOTS
THROUGHOUT NORTH AMERICA

BOSTON • NEW YORK • CHICAGO • LOS ANGELES • HOUSTON • SAN FRANCISCO • CLEVELAND
JACKSONVILLE • DENVER • SEATTLE • BALTIMORE • TORONTO • MONTREAL • VANCOUVER

6005

Announcing...
Revolutionary
NEW
WILKERSON
desiccant compressed air
DEHYDRATOR
for "instrument-pure" air

The NEW "Chem-Guard" package provides micro-clean, dehydrated oil-free air **only where needed!**

NEW Exclusive features found only in the Wilkerson "Chem-Guard":

★ **LOWEST PRICE** for package, application and installation. No electrical water or sewer connections needed.

★ **DEPENDABILITY** of "Chem-Guard" dehydrator assured because of no moving or mechanical parts.

★ **SIMPLIFIED, ECONOMICAL SERVICING**—No draining or reactivating is necessary. Exact amount of replacing chemicals available in vacuum packed cans.

★ **BUILT-IN VISIBLE INDICATOR** shows color change when servicing is required.

Your choice of 3 non-corrosive chemicals . . .

(a) Silica-Gel reduces dew point to —40° F., (60° below safe standard of 20° F)
(b) Molecular Sieve reduces dew point to —100° F.
(c) Another removes traces of oil to 10 parts per million.

WRITE TODAY for circular #1040 giving complete specifications and information

WILKERSON CORPORATION

1643 W. Mansfield Englewood, Colo.

Dedicated to keeping the NEW in pNEUmatics

Circle **127** on Reader Service Card

on the flow control flange is sufficient to move the flange against the spring force, closing the poppet valve at the pump's outlet.

U. S. Patent No. 2,938,469 by John A. Lauck, assigned to Borg-Warner Corp., Chicago.

Synchronizing Regenerative Cylinders

When two cylinders, being synchronized, extend in regenerative circuits any difference in flow to the cylinders is present in the same percentage in the regenerative circuit.

A cross-regenerative circuit decreases the effect of difference in flow and the cylinders extend in closer synchronization.

In a cross-regenerative circuit the rod end of one cylinder connects to the head end of the other cylinder. As the cylinders extend in a regenerative circuit, fluid from the rod end of one cylinder flows into the head end of the other cylinder.

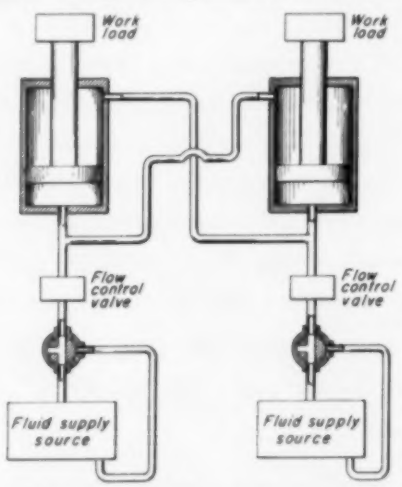
The following formulas may be used to calculate the difference in the cylinder velocities with a conventional regenerative circuit and a cross regenerative circuit. The formula for total flow to the head end of a cylinder with a conventional regenerative circuit is:

$$Q = Q_t + Q\left(\frac{\text{annular area of the piston's rod end}}{\text{area of piston head end}}\right)$$

Where

Q = Total fluid flowing into the head end
Q_t = Metered flow to the cylinder

Assume that two identical cylinders are being synchronized by metering flow to them, and each cylinder is extending in a regenerative circuit. The piston



rod annular area is ½ the area of the head end. Discharge from one flow control valve is 100 cipm and from the other 90 cipm (assuming a 10% error in flow control valve setting).

Substituting these values in the above formula:

$Q = 100 + Q\ (½) = 200$ cipm into head end of cylinder 1

$Q = 90 + Q\ (½) = 180$ cipm into head end of cylinder 2

The 10% variance in flow to the two cylinders remains at 10% in the differential circuit.

The formulas for determining the flow rates in a cross regenerative circuit are:

$$Q_1 = Q_{r1} + Q_2\left(\frac{\text{annular area of the piston's rod end}}{\text{area of piston head end}}\right)$$

$$Q_2 = Q_{r2} + Q_1\left(\frac{\text{annular area of the piston's rod end}}{\text{area of piston head end}}\right)$$

Where

Q_1 = Total flow into the head end of cylinder 1
Q_2 = Total flow into the head end of cylinder 2
Q_{r1} = Metered flow to cylinder 1
Q_{r2} = Metered flow to cylinder 2

Assume again that the cylinders are identical and are synchronized by metering flow to them. They extend in a cross-regenerative circuit and the piston area of the rod end is ½ the area of the head end. One flow control valve meters 100 cipm and the other 90 cipm.

Substituting these values in the above formulas:

$Q_1 = 100 + Q_2\ (½) = 186\ 2/3$ cipm into the head end of cylinder 1

$Q_2 = 90 + Q_1\ (½) = 193\ 1/3$ cipm into the head end of cylinder 2

In this circuit the 10% variance in flow to the two cylinders is reduced to about 4.6% in the regenerative circuit. Since the velocity at which the cylinders extend is in direct relation to the flow into the head end, a cross-regenerative circuit offers closer synchronization.

U. S. Patent No. 2,940,262 by Robert E. Pfitzenmeier, Fanwood, New Jersey.

GORTITE

All GORTITE, pliable, protective parts are fabricated from new, neoprene-base materials, nylon coated fabrics, fiberglass, Teflon, etc., to meet individual, service conditions: There are materials to withstand temperature extremes from —40°F., to 500°F., without cracking.

A&A MFG. COMPANY INC.
712 S. 12th St.
Milwaukee 4, Wisconsin

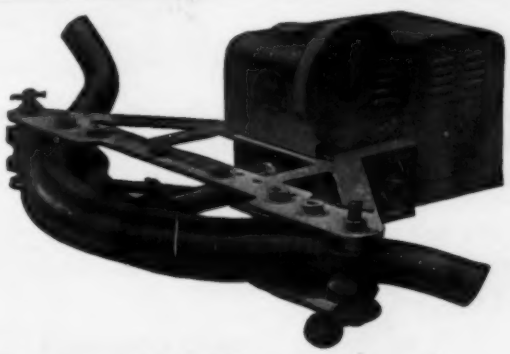
BELLOWS . . . BOOTS . . . SLEEVES . . . WAY-PROTECTORS FOR HYD. CYLINDERS, RAMS, JACKS, WAYS, ETC.

Circle **1** on Reader Service Card

STAFFA

HIGH TORQUE VARIABLE SPEED (1-100 r.p.m.) HYDRAULIC MOTORS

Mark IV—5 cylinder 4,500 lbs. ft. at 2,000 p.s.i. (Speed 1—100 R.P.M. reversible). Overall efficiency 90%—95%.
Mark V—7 cylinder 6,600 lbs. ft. at 2,000 p.s.i. (Speed 1—75 R.P.M. reversible). Overall efficiency 90%—95%.
Ideal drive for conveyors, rolling mills, cranes, tractors, cement mixers, drills, and most mechanical handling applications.



4" HYDRAULIC BENDER

Standard equipment includes 2"—4" formers for steam and gas pipes. The machine can be supplied either **Hand Operated** or **Motorised** and accessories are available for ⅜"—1¼" steam and gas pipes, flat bar bending up to 7" x ⅝" section and electrical conduits up to 3".

A complete range of Hydraulic Pipe and Tube Benders ¼" to 18" dia. Pipes is available.

CHAMBERLAIN INDUSTRIES LTD.

Staffa Works, Argall Ave., Leyton, London, E.10, England.
Leytonstone 3678
(MEMBER OF THE CHAMBERLAIN GROUP OF COMPANIES)

Circle **26** on Reader Service Card

POSITIVE AUTOMATIC PRESSURE CONTROL?

CHECK YOUR REQUIREMENTS AGAINST FULFLO SPECIFICATIONS

- Screw or flange models
- Pressures to 500 pounds
- Pipe sizes to 3"
- Steel, cast iron or brass bodies
- Brass, steel or stainless trim
- All-steel for extra safety

FULFLO gives you what you want in safe, trouble-free and quiet operation for any hydraulic system. Shear-closing action eliminates chattering; sliding piston gives full flow opening; distinctive construction allows easy adjustment within the valve's pressure range or change of the pressure range.

Whatever your requirement . . . for O.E.M. use or replacement service . . . there's a FULFLO Oil By-Pass Relief Valve designed just right, built right and priced right, too!

NEED A "Special"?

FULFLO can engineer a special valve to your most exacting requirements. Examples of "specials" are shown in Data Book.

FOR EXTRA CONVENIENCE

Where frequent pressure setting adjustment is needed, install a FULFLO Hand Wheel Valve. Made in a variety of styles.

FOR COMPLETE INFORMATION, request a copy of the FULFLO Valves Mechanical Data Book with complete specifications and engineering data.

"FULFLO" TRADE MARK REG. U.S. PAT. OFF.

THE FULFLO SPECIALTIES CO., INC.

415 Fancy Ave. Blanchester, Ohio

Circle **43** on Reader Service Card

NEW PRODUCTS

Continued from page 58

MIDGET ACTUATOR

With reciprocating rotary movement. For use on light applications such as instruments, computers, calculating machines, switches,

chemical controls, carton construction machines, and remote control of valves.

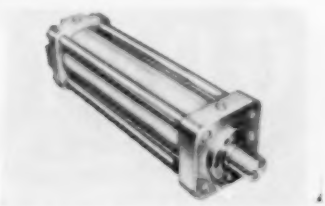
Specifications: 2" square, 2" long. Up to 300 psi. Single-vane model rotates 270 deg. Double-vane model rotates 90 deg, but with double power.

Designation: Midgets.—*Ex-Cell-O Corp., Greenville, Ohio.*

Circle **305** on Reader Service Card

DOUBLE-ACTING CYLINDERS

Choice of stroke length and mounting. Self-adjusting flange-type rod seals.



Specifications: 10,000 psi. Capacities of 50, 75, 100 and 150 tons. Bore sizes are 3¼", 4½", 5¾" and 6¾". Polished 10-15 micro-finish.

Designation: YD series.—*Precision Hydraulics Div., Owatonna Tool Co., Owatonna, Minn.*

Circle **306** on Reader Service Card

QUICK-CONNECT COUPLINGS

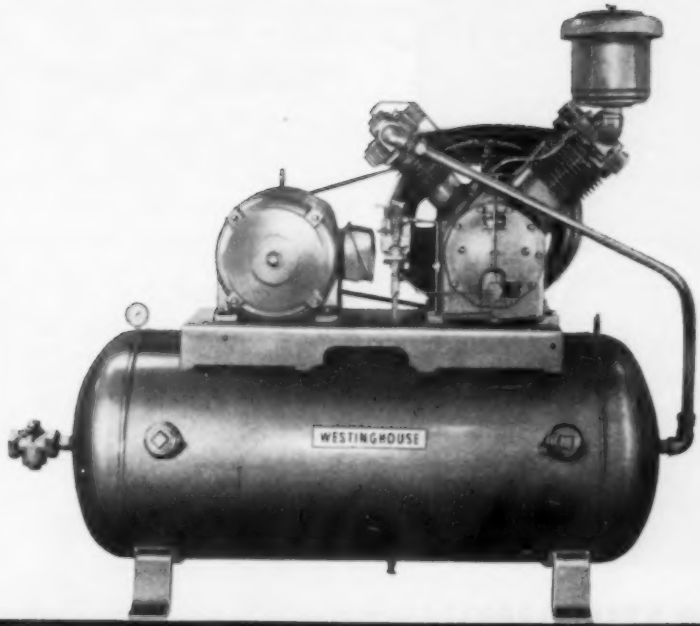
Interchangeable sockets and plugs. Permit connecting pipe to hose, to plastic, etc. One-hand automatic locking.

Specifications: Three end-connection styles: for thin wall plastic

Continued on page 132

Circle 70 →

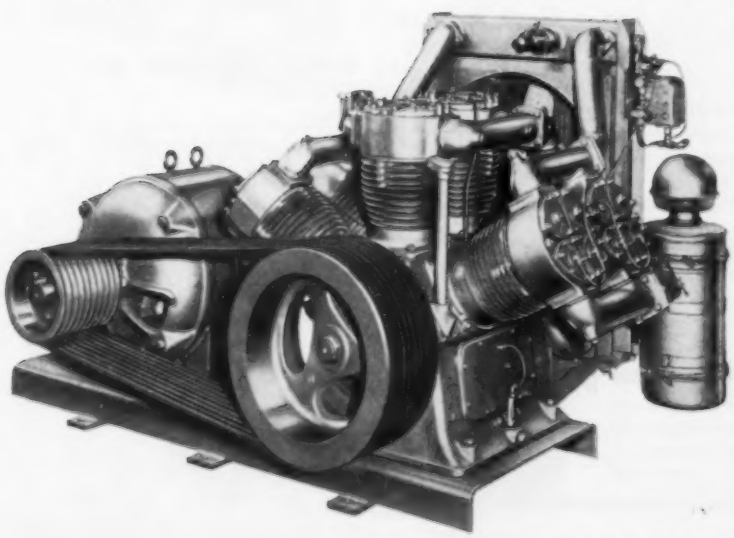
Make LE ROI your one-stop source for AIR COMPRESSORS



WESTINGHOUSE unit type ½ to 15 hp. 17 models: 2 to 71.7 cfm—80 to 250 psi

WESTINGHOUSE single- and two-stage compressors are ideal for jobs in the unit type class with moderate air demand. You get long-lived dependability at low first cost. Upkeep is negligible. Units incorporate thermal overload protection, positive starting unloader, air cooled deep-finned cylinders, and corrosion-resistant automatic spring loaded floating valves.

Crankshaft is ball-bearing mounted for stability, and matched V-belt set assures balanced drive line wear. Compressors are available with horizontal or vertical tank, or bed-plate mounting. Load-unload or start-stop control is standard. Options include dual control, water-cooled aftercooler, and automatic drain valve for receiver.



LE ROI stationary type 25 to 100 hp. 4 models: 92 to 450 cfm at 125 or 175 psi

LE ROI stationary compressors provide economical and flexible air power for your heavy industrial jobs. Made in 25, 50, 75, and 100 hp sizes, these two-stage units can be used as central air supply — or you can spot units at various points of use, thus minimizing pipe runs and air loss. Air-cooling permits indoor and outdoor use, and compactness conserves space.

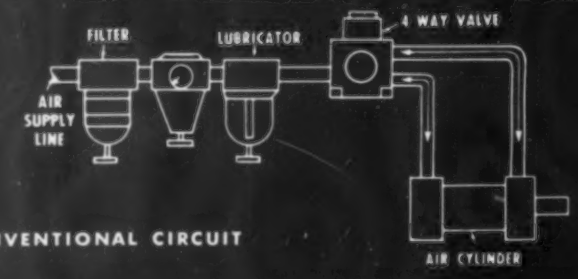
Features like forced-feed lubrication, large intercooler, high-speed fan, and balanced design extend motor and compressor life and cut upkeep. You can pick standard models with either dual control or continuous running load-unload control. Option extras include: crankcase oil filter, oil pressure safety switch, intake silencers, belt and intercooler guards, and water-cooled intercooler.

Ask your Le Roi Distributor for additional information. Or send for Bulletin SG-3 covering the entire line. Write to Le Roi Division, Westinghouse Air Brake Co., Sidney, Ohio.

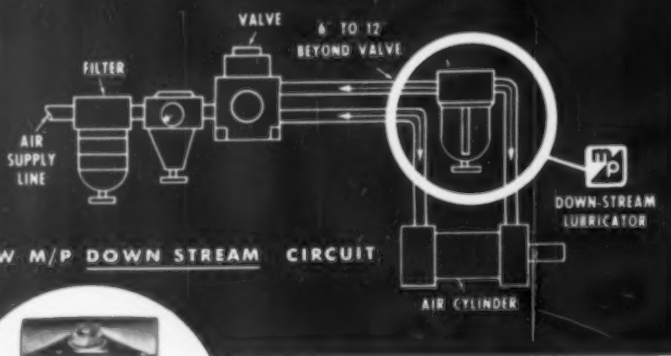
SC-102

LE ROI Division of Westinghouse Air Brake Co. Sidney, Ohio

NEW M/P CONCEPT
OF AIR CYLINDER LUBRICATION



CONVENTIONAL CIRCUIT



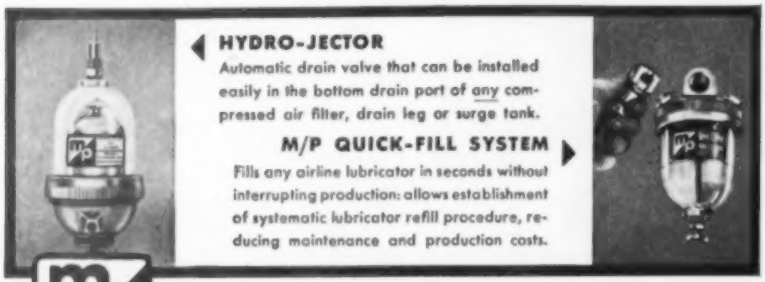
NEW M/P DOWN STREAM CIRCUIT

DESIGNED SPECIFICALLY FOR AIR CYLINDERS

With a conventional circuit the air cylinder may not be lubricated because oil introduced by the lubricator is trapped in the valve and exhausted to atmosphere. Any small amount of oil that works through the valve may also be exhausted when the cylinder is reversed.

Now . . . M/P has developed a new concept of air cylinder lubrication. The new Lubricator (Model M204) installed in the *Down-Stream Circuit* assures lubrication of both the control valve and the cylinder.

Contact your local representative or M/P for a detailed brochure.



HYDRO-JECTOR
Automatic drain valve that can be installed easily in the bottom drain port of any compressed air filter, drain leg or surge tank.

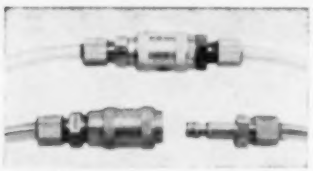
M/P QUICK-FILL SYSTEM
Fills any airline lubricator in seconds without interrupting production: allows establishment of systematic lubricator refill procedure, reducing maintenance and production costs.

MASTER PNEUMATIC, INC.
20430 SHERWOOD • DETROIT 34, MICHIGAN • Phone: TWinbrook 3-7070

Circle **78** on Reader Service Card

NEW PRODUCTS

tubing ¼" and 1.70" I.D.; pipe lines and rubber hose, ⅜ NPT male, female and ¼" hose stem connec-

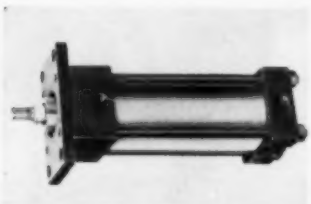


tions; and compression fitting for brass aluminum, or copper tubing, 3/16" and ¼" O.D.—*Perfecting Service Co., Charlotte.*

Circle **307** on Reader Service Card

AIR CYLINDERS

100% interchangeable with conventional cylinders. Built to JIC standards. Bearing plate held with cap screws. Fatique-proof steel piston rods.



Specifications: From 1½" to 14" bore diameter. Stroke as required. **Designation:** Series 130—*W. E. Hennells Co., Inc., Belleville, Mich.*

Circle **308** on Reader Service Card

QUICK-ADJUSTING AIR REGULATOR

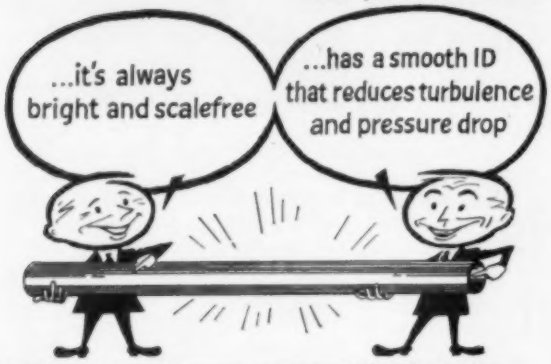
Lever and coarse adjusting screw replaces standard adjustment. Two

gauge ports or 3 outlets, self-relieving or non-relieving, balanced

Continued on page 134

Circle **116** on Reader Service Card

TubeXperience in Action



And here are 8 more reasons why Superior (SAE) Hydraulic Steel Tubing is your best buy

- *Ease in bending and flaring*, with no loss of ductility in storage and service, through use of 0.12% max. carbon content nonaging steel
- *Consistently uniform tubing* through careful inspection of raw material and tubing in process
- *Assured cleanliness* by hot solvent degreasing before all process anneals and shipment
- *Flare-inspected quality* based on 35% increase of OD
- *100% hydrostatic testing* to recommended working pressures
- *Rust preventive treatment* of all tubing before shipment
- *All tubing boxed and wrapped* for cleanliness and to protect against bending and denting during shipment or in warehouse storage
- *A complete range of sizes* stocked by leading steel service centers

FREE! Bulletin 39, which contains bending data, working and bursting pressures and flow information. Write Superior Tube Company, 2030 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing
NORRISTOWN, PA.

All analyses .010 in. to ¼ in. OD—certain analyses in light walls up to 2½ in. OD
West Coast: Pacific Tube Co., Los Angeles, Calif. • FIRST STEEL TUBE MILL IN THE WEST

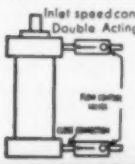
Get Easier, More Accurate Cylinder Speed Control

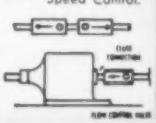
with Pneu-Trol® VALVES IN AIR OR HYDRAULIC USE

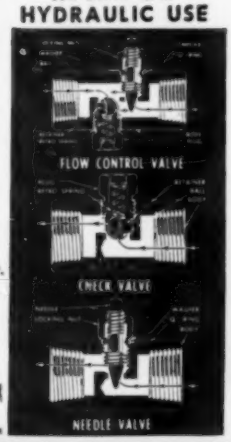
2,000 (brass or aluminum) and 5,000 (steel) p.s.i.

Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check Valve and Needle Valve incorporate single function features of Flow Control Valve. All valves available in 5 female pipe sizes — ⅛" to ¾". Valve bodies are made from brass, aluminum, steel or stainless steel. Attractive Prices — Immediate Delivery.

Write for Illustrated Circular and Price List.



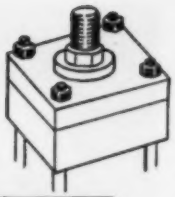




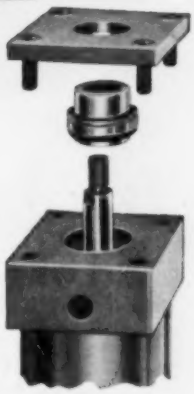
AUTOMATION AUTO-PONENTS INC
2919 GRANT STREET
BELLWOOD (Chicago Suburb) ILLINOIS

Circle **13** on Reader Service Card

Why This?



When This Can Be Yours!



Mo-Bar Air and Hydraulic Cylinders cannot fall apart . . . because of loose tie-rods . . . when you remove the rod bushing and cartridge retainer plate of these cylinders.

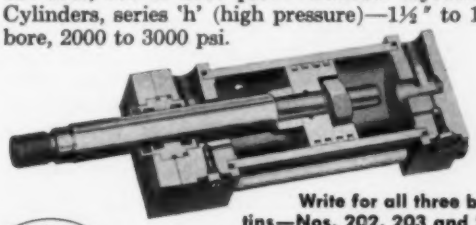
Mo-Bar's *exclusive* feature of using four (4) Allen Head cap screws in place of conventional protruding hex nuts . . . permits easy, quick replacement of the entire cylinder Rod Cartridge assembly . . . with cylinder barrel and tie-rods always permanently in place.

This Mo-Bar "first" gives greater design flexibility . . . particularly for cylinder mounting in tight places.

Other Mo-Bar "firsts" include (1) improved Rod Cartridge design where the long bronze rod bushing is *piloted* into cylinder head—not threaded—for maximum piston rod support . . . and (2) oil-heat resistant, self-adjusting Seal Guard wiper rings, with long conical taper, to throw off all harmful matter from piston rods.

The unique Mo-Bar compact design for air and hydraulic cylinders assures superior performance and unfailing dependability with positive, uniform actuation at all times.

There are Mo-Bar Air Cylinders, series 'a'—1½" to 14" bore, to 200 psi . . . Mo-Bar Hydraulic Cylinders, series 'm' (medium pressure)—1½" to 14" bore, 500 to 2000 psi . . . Mo-Bar Hydraulic Cylinders, series 'h' (high pressure)—1½" to 12" bore, 2000 to 3000 psi.



Write for all three bulletins—Nos. 202, 203 and 204—describing Mo-Bar Air and Hydraulic Cylinders for fluid power applications . . . Dept. B,

MO-BAR HYDRAULICS CO.
Crystal Lake, Illinois

Circle **85** on Reader Service Card

A few words about Couplers from Earl F. Bruning

Fourteen years ago those of us who were most concerned saw that before the art of hydraulics could fulfill its most extravagant promises, there would have to be found a simpler way of connecting fluid lines. It would have to be a precise way, too, because in handling fuels and liquids in the years ahead, no spillage or air inclusion could be acceptable.

At The Bruning Company, we believe we have a family of quick-disconnect couplers that is definitely superior, exhibiting very low flow resistance and turbulence, and with operating pressures from 6,000 to 10,000 P.S.I. and up.

The Bruning line of couplers is the broadest in the industry. Models can be furnished for nearly any fluid medium, ranging from simple hydraulic fluids to the most exotic liquids and fuels—even under extreme temperature conditions.

Types include self-sealing and open-flow, self-locking and slip-joint, and various models for connecting and disconnecting under pressure.

Because we have become specialists in this field and enjoy a remarkable degree of employee cooperation and enthusiasm, we have been able to price most of our couplers substantially below competitive models.

Please let us know your application specifications so that we can send you a sample Bruning coupler.

THE BRUNING COMPANY

LINCOLN, NEBRASKA

Phone—HE 5-3511 • TWX—LI 8151

Circle **22** on Reader Service Card

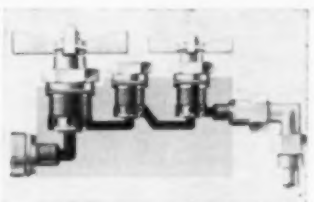
NEW PRODUCTS

valve construction and nylon reinforced diaphragm.
Specifications: Maximum inlet and outlet pressures are 300 psi and 125 psi. Full turn of lever adjusts from 0 to 125 psi.
Designation: Model 2016—*Wilkerson Corp., Englewood, Colorado.*

Circle **309** on Reader Service Card

VALVE CARTRIDGE INSERTS

Flat seat, sealed with an O-ring. Bubble-tight shut-off at pressures to 6000 psi.



Specifications: Temperatures from −20 to 275 F. Sizes from ¼" to 2".
Designation: CPV O-Seal.—*Combination Pump Valve Co., Philadelphia.*

Circle **310** on Reader Service Card

PORTABLE DIESEL COMPRESSORS

Engine and compressor in one unit. Power of four-stroke engine goes direct to compressor by means of main and auxiliary connecting rods.

Specifications: Air chamber capacity 52 cubic feet, with safety valve set for 112 psi. 9-gal fuel system.
Designation: Jenbach JW440KF.—*Chamberlain Plant Ltd., Crown Works, Middlesex, England.*

Circle **311** on Reader Service Card

HEAT EXCHANGERS

Handle any combination of fluids. May be used as heaters, coolers,

Continued on page 136

Circle **109** on Reader Service Card

LOCK OUT AIR FOR MACHINE REPAIR

Ross

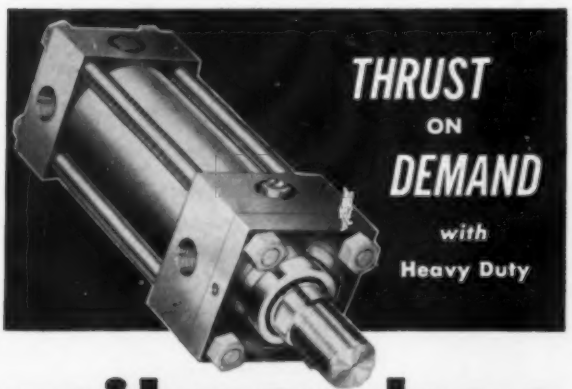
Locks
Out and
e**X**hausts
VALVE

Lock out air that operates a machine, as a safeguard when making machine repairs. The Ross L-O-X Valve installs in the supply line leading to the machine, upstream of any operating valve. Designed so that when closed, supply-air to the machine is shut off and air downstream is exhausted. Can be padlocked in this position.

More L-O-X valves can be incorporated in the circuit to shut off and exhaust various segments of the circuit. Detented open; very low pressure drop; Lightweight aluminum construction. Call your Ross representative or write for literature.

ROSS OPERATING VALVE CO.

105 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.



milwaukee Cylinders

Quality Construction Throughout.
Guaranteed Top Performance.
No Costly Down Time.
Precision Designed—Heavy Duty Service.
Conforms to JIC Specifications.

Write today for Free Bulletins A-100 and H-100.

Standard Models
Hydraulic Bore Size 1½ to 12"
Air Bore Size 1½ to 14"

Specials built to your specifications

MILWAUKEE CYLINDER CO.
Division of L. & M. Machine Company
5755 SOUTH PENNSYLVANIA AVENUE • CUDAHY, WISCONSIN

Circle **83** on Reader Service Card

REPUBLIC VALVES FOR EVERY INDUSTRY

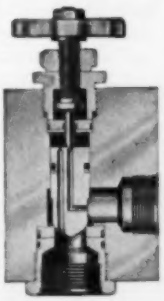
EXTRA HIGH PRESSURE FINE METERING

HIGH PRESSURE NEEDLE VALVE

10,000 psi hydraulic service. Forged stainless steel one-piece body. Panel mounting. Good flow characteristics, fine metering, easy to turn. Water, gas, oil and vacuum service, ⅛" to ½" pipe or straight thread tube connections.

MICROMETER ADJUSTMENT NEEDLE VALVE

Best for extra fine metering. Micrometer adjustment, precision taper stem. 5000 psi service –65° to 350°F., oil, water, etc. Brass, aluminum alloy, steel, or stainless steel body. ⅛" and ¼" sizes. Premolded or O-ring packing. Panel mounting.



5000 psi THROTTLE-FLO VALVE

Accurate throttling up to 5000 psi. Finger tip control. Pilot operation of large dynamically balanced piston. Full flow, yet accurate to 1/100 gpm through entire range. Positive seal. Low pressure drop. Aluminum alloy, ½", ¾", 1" internal straight thread connections. Hydraulic seals — others available.

HYDRAULIC BLEEDERS

Primarily used for bleeding air from hydraulic systems, for working pressures to 3000 psi at temperatures from –65° to 180°F.

Fluid control valves of many types have been developed and are manufactured by REPUBLIC. A wide line of quality standard valves includes needle, globe, check, plug, selector and relief valves, as well as other units for industrial, chemical, aircraft, missile and ground handling equipment.

Specialists in valving and manifold design to meet your specific application. Write for catalog.

Distributors in principal cities coast to coast

RM REPUBLIC MANUFACTURING CO.

15655 BROOKPARK ROAD • CLEVELAND 35, OHIO

Circle **105** on Reader Service Card

Circle **47** on Reader Service Card

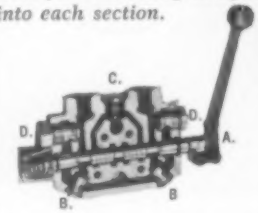
DESIGNERS:

"Here's everything you want in a multi-spool valve."

For heavy-duty mobile applications.

SECTIONAL CONSTRUCTION

with full versatility designed into each section.



A. Handle may be located at either end.
B. Anticavitation checks optional at one or both cylinder ports.
C. Load-checks in all sections.
D. Either ball-spring or pilot-type cylinder port relief optional in one or both ports.
E. Left end section includes inlet and outlet at either top or side option of ball-spring or pilot-type main relief.
F. Right end section options: Power-beyond, conversion plug, outlet or closed-center plug.
G. Individual sections may be replaced or added in the field.

Now you can specify Gresen Directional Control Valves in banks of 2, 3, 4 . . . as many as eight sections, with any combination of features in each section. Take your choice of 3-way, 4-way, free-flow or 4-position float sections in any arrangement, then add the options shown at the left.

Available port sizes: ½", ¾", or 1" NPTF, or SAE Nos. 8, 10, 12, or 14 (outlet ports to SAE No. 16). Maximum pressure: 2500 psi. Capacity: 35 gpm. Ask about models 25P and 25PK.

GRESEN
MANUFACTURING CO.
405 - 35th AVENUE N.E., MINNEAPOLIS 8, MINN.

GRESEN HYDRAULICS

Capital's "GUARDIAN"
FILTER FLOW METER
WARNS
when filter needs cleaning!

A NEW Hydraulic Filter Flow Meter, equipped with a built-in device which warns by turning on a red light when liquid flow falls below a pre-set volume.

This new Capital "GUARDIAN" Filter Flow Meter can be set to turn on light or to turn off power supply to equipment until filter is cleaned or replaced. It is a time saving device that protects costly machinery from damage. It is entirely automatic in operation.

Using a by-pass defeats the purpose of the filter because it permits a great deal of harmful foreign matter to enter into the system when fluid by-passes the filter screen.

CAPITAL'S ALL PURPOSE FILTERS

Capital All Purpose Filters include Reservoir and Line Types with Mono-Bilt and Mono-Econo Monel Metal inserts.

Capital Filters are impervious to Hydraulic Fluids, Fuel Oils, Lube Oils, Coolants, Paints and Varnishes, Water and most Chemicals.

Ask for descriptive literature TODAY!

CAPITAL
ENGINEERING & MFG. CO.
5837 So. Ashland Ave.
Chicago 36, Illinois

Circle **23** on Reader Service Card

NEW PRODUCTS

condensers, or vaporizers.
Specifications: Shell sizes from 8" to 42", any length. From 75 to 300

psi. Temperatures to 400 F. Types 304 or 316 stainless steel, cast iron, brass, or carbon steel.
Designation: C-200.—*American-Standard Corp., Industrial Div., Detroit.*

Circle **312** on Reader Service Card

RELIEF VALVES

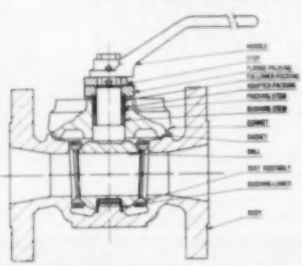
Two pilot-operated relief valves designed for SAE hydraulic straight threads and pipe threads.
Specifications: 5 to 1 safety factor over rated operating pressure. Line mounted on valves for 3000 psi.

Gasket mounted, 5000 psi. Capacities, 20 and 50 gpm.—*Parker-Hannifin Corp., Cleveland.*

Circle **313** on Reader Service Card

BALL VALVES

Removal of bonnet flange permits easy access to ball and seats without removing valve. Seat adjusted externally by two hex nuts on bonnet. Low torque manual operation,



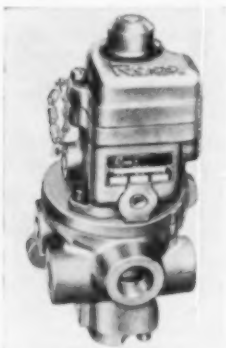
and straight through flow. No-float ball fixed between top and bottom

guides, to withstand shock and impact without distortion or backlash.
Specifications: 90-deg turn opens and closes valve. To 150-psi pressure. 1", 1½", 2", 3", 4", 6", and 8" diameters.
Designation: Flo-Ball—*Hydromatics, Inc., Bloomfield, N. J.*

Circle **314** on Reader Service Card

ELECTRO-HYDRAULIC AIR VALVE

Air or solenoid operated. 3-way or 4-way types. J.I.C. standards. Body and poppets of anodized aluminum alloy.
Specifications: ¼" to 1-¼" pipe sizes. Pressures of 30 to 150 psig

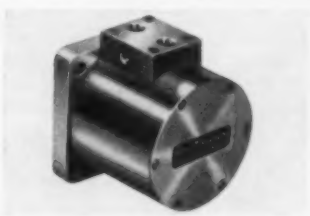


in head and 5 to 150 psig in body. Temperatures from 40 to 175 F.
Designation: Headline—*Ross Operating Valve Co., Detroit.*

Circle **315** on Reader Service Card

ROTATING VANE HYDRAULIC MOTOR

Constant displacement, low inertia and oil volume. Recommended as



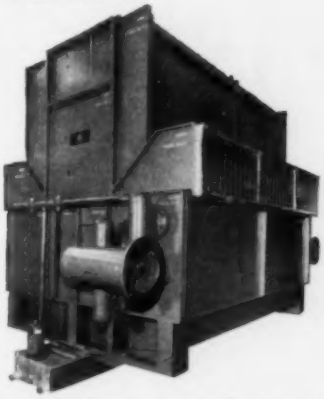
servo motor in speed control systems. For standard flange mounting, coupled use, and with double shaft extension.
Specifications: Displacement from 2.2 to 7.6 cu-in./rev. Torque, 35 to 121 in.-lbs/100 psi. 15 to 41.5 hp. Speeds to 1500 rpm. Pressure to 2000 psi. From 5⅝" to 7⅞" dia.
Designation: Rol-Vane.—*Hartmann Mfg. Co., Racine, Wis.*

Circle **316** on Reader Service Card

▼▼▼

Circle **89** on Reader Service Card

You Get EXTRA SAVINGS From This Method of Compressed Air After Cooling



Cooling water savings and power savings quickly repay the cost of the Niagara Aero (air-cooled) After Cooler for compressed air or compressed gases. In addition its long life and the labor-saving simplicity of its maintenance give you an extra profit in comparison with water-cooled surface contact methods.

With the Niagara After Cooler the heat of compression is removed and dispersed into the atmosphere by the evaporation of a very small amount of water. The compressed air temperature is always brought below that of the atmosphere surrounding your air lines, so that no further condensation can take place.

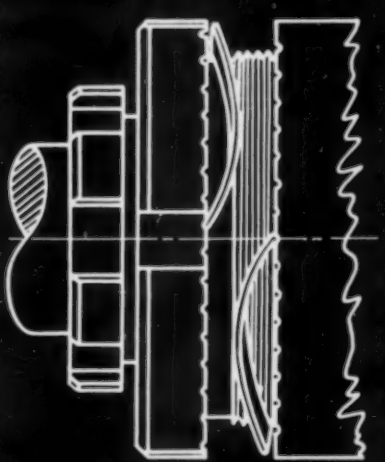
Large users of compressed air for plant services or processes choose Niagara Aero After Coolers for their dependable durability. They have been making good records of service for over 25 years.

Write for Bulletin 130.

NIAGARA BLOWER COMPANY
Dept. AH-4, 405 Lexington Ave., New York 17, N. Y.
Niagara District Engineers in Principal Cities of U. S. and Canada

IMAGINATION FOR SALE!

LOCKING PROBLEM?



This simple solution for locking a cylinder to a cylinder end is an example of Universal Hydraulics' "creative common sense." A wavy washer is squeezed between the knurled surfaces of the connecting parts . . . forming a lock so strong that threaded parts can withstand severe shock and vibration. For a solution to your hydraulic problem, call or write us.

UNIVERSAL HYDRAULICS
DIVISION OF HOLAN CORPORATION • 4500 BEIDLER ROAD • WILLOUGHBY, OHIO • WHITEHALL 2-4595
Circle **120** on Reader Service Card

ROPER PUMPS

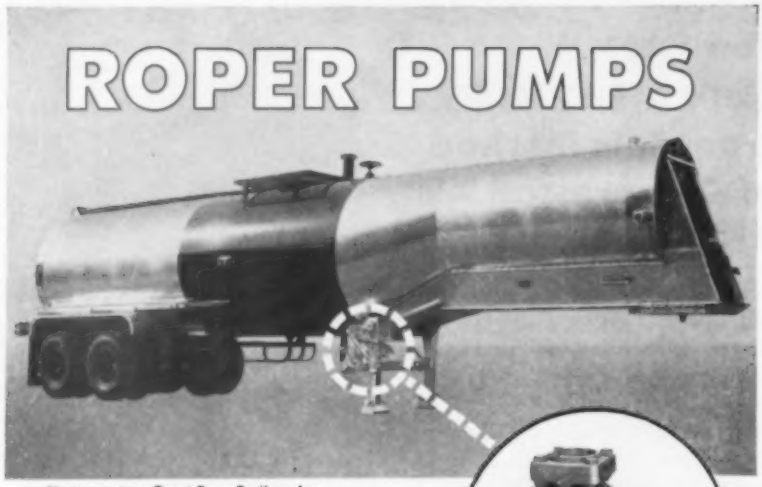


Photo courtesy Great Dane Trailers, Inc.

Series 3600

SERIES 3600

handle widely different products in dual-purpose tank trailers

CAPACITY: 40-300 GPM • PRESSURES TO 100 PSI

A fleet of dual-product trailers built by Great Dane Trailers, Inc., Savannah, Ga., hauls tall oil, a highly viscous resin by-product, one way and returns with low viscosity gasoline. Roper Series 3600 MAHBRV #4 tank truck pumps were installed on these trailers because of this necessity of handling widely different products. Each pump is directly connected to the tank trailer and to a discharge pipe which permits controlled unloading from either side of the trailer. Each pump is equipped with a relief valve. Series 3600 pumps are available in high- or low-drive models for clockwise or counter-clockwise rotation. They can be side frame or cradle mounted on right or left side.

FOR DOUBLE-DUTY SERVICE

- **BEARINGS:** service-free high-lead bronze, lubricated and cooled through oil grooves by flow of liquid through pump.
- **OUTBOARD BEARING:** heavy-duty ball bearing diverts drive and thrust loads from pumping gears and inner bearings.
- **GEARS:** two equal-sized, hardened alloy iron, helical-type gears with accurately machined special tooth forms reduce friction, eliminate vibration.
- **PACKED BOX OR MECHANICAL SEAL:** extra deep packing box easily repacked with split ring packing and split gland without disconnecting drive or piping. Mechanical seal (3605) is self-adjusting with precision-lapped mating surfaces for positive sealing and long life.

For information about your specific pump needs contact your nearest Roper dealer

Send for "How to Solve Pumping Problems" booklet

ROPER HYDRAULICS, INC.

Dependable pumps since 1857

COMMERCE, GEORGIA

Circle **107** on Reader Service Card

NEW LITERATURE

Continued from page 64

HIGH TORQUE FLUID MOTOR

Provides continuous torques to 10,000 ft-lbs. Speeds from 0 to 100 rpm. Continuous pressures to 2000 psi, peak 3000 psi. Pistons have 3" stroke, 4" bore. Instant reversal. —*Manufactured by Chamberlain Industries, London. U.S. representative Double A Products Co., Subs. Brown & Sharpe Mfg. Co., Manchester, Mich.*

Circle **414** on Reader Service Card

VALVES

For use in minimizing effects of abrasive and corrosive fluids. Pilot operated with no spools, poppets, or sliding seals. When pilot valve is open, media flows freely from inlet port through main valve to outlet port. To close valve pilot, pressure is applied between main valve body and outer periphery of rubber sleeve. Sleeve collapses over inlet and outlet plugs, sealing off media flow. Catalog gives information on sizes ¼" to 2½". Also available are sizes 3" to 12" flanged. Operates at 1:1 pilot-to-media ratio. Rating is 500 psi.—*Airmatic Valve Inc., Cleveland.*

Circle **415** on Reader Service Card

PNEUMATIC AND HYDRAULIC TESTS

Laboratory offers compressed air testing, hydraulic testing, flow rates, life tests, leak detection, and design and fabrication of special test panels. Automatic life tests on control valves using pressures to 500 psi.—*Boyle Engineering Lab., Chicago.*

Circle **416** on Reader Service Card

LIMIT SWITCHES

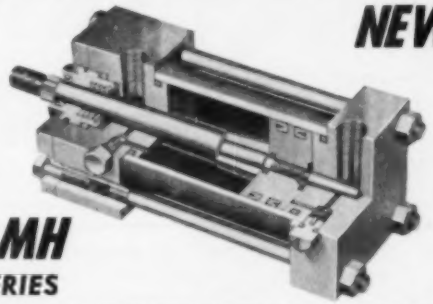
Catalog No. 100 details open blade, subminiature, miniature, machine tool, general purpose, and relay switches. Includes price lists, illustrations and dimensions.—*Robertshaw-Fulton Controls Co., Columbus, Ohio.*

Circle **417** on Reader Service Card

▼▼▼

Circle **111** on Reader Service Card

NEW!



MH SERIES

COMPACT, MEDIUM PRESSURE, ECONOMY-PRICED HYDRAULIC CYLINDERS!

● Ideal for special or machine tool applications ● Ten bore sizes, 1-1/8" thru 8" ● Dimensionally interchangeable with "A" series ● Pressures up to 2000 psi ● 18 standard mountings ● Straight thread ports at no extra charge ● Tapered cushions ● Multi-lip rod seals, replaceable without disassembly of cylinder ● Meets J.I.C. standards.

THE SHEFFER CORPORATION

Cincinnati 15, Ohio
Phone POplar 1-8227

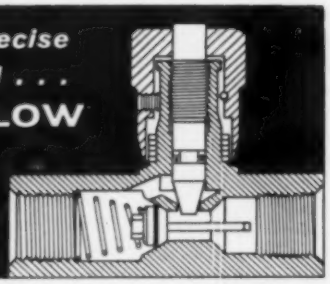
Write for NEW full color 20-page Bulletin No. 361, NOW!

SOLD BY LEADING DISTRIBUTORS INTERNATIONALLY

SEE PHONE BOOK YELLOW PAGES

For more precise Flow Control . . .

COLORFLOW FLOW CONTROL VALVES



. . . with exclusive color and number calibrated adjustment

- **Simple reading, recording, setting and adjusting**
- **Safe — adjustable under pressure**
- **Setting can be locked to hold adjustment**
- **Extremely sensitive — provides high flow and minimum pressure drop**

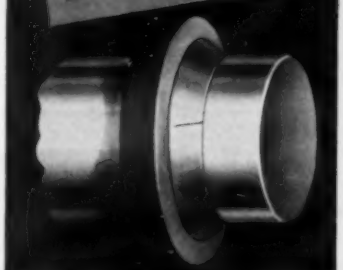
- **For oil, gas, vacuum, water and other fluids**
- **Pressures: Brass to 2000 psi Steel to 5000 psi**
- **Sizes: ⅛, ¼, ⅜, ½ and ¾" dry seal pipe threads**

Write for detailed literature

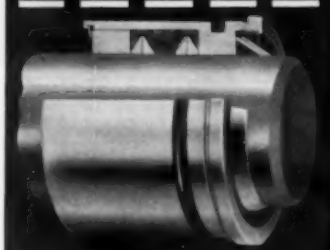
THE MANATROL Corp.
2372 W. 7th St. • Cleveland 13, O. • CH 1-0575

Circle **76** on Reader Service Card

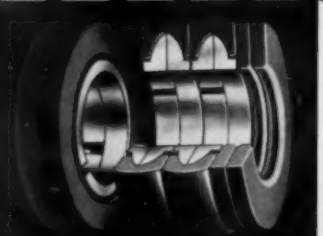
TOP QUALITY YOUR *Best* PROTECTION!



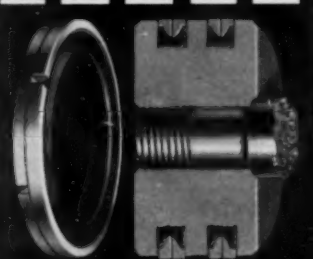
Seal-Guard
METALLIC ROD WIPERS
"Wipe off" dirt accumulation with rubber mounted, flexible bronze knife edges. Perform better, for longer.



MONOPAK CARTRIDGE
Compact, all-in-one package of packing, bearings, and rod wipers. Air or hydraulic cylinders. No machining or adjustments.



MONOPAK ROD PACKING
A highly efficient bearing and seal package for air or hydraulic use. Available in all desired sizes.



MONOPAK PISTON PACKING
A long lived, trouble-free, automotive type ring and packing for one or two piece pistons.

YOUR ASSURANCE OF BETTER PNEUMATIC OR HYDRAULIC SEALING.

Complete details and prices on request.

HYDRAULIC ACCESSORIES COMPANY

24301 Hoover Road
Warren, Michigan

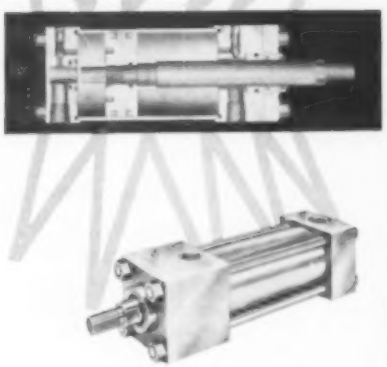
Circle **56** on Reader Service Card

NEW O-M AIR CYLINDER

Series K·200 psi

1½" to 14" Bores

Meets JIC Standards



BUILT TO EXACTING O-M SPEC'S. DIMENSIONALLY INTERCHANGEABLE

Ortman-Miller proudly presents, as an addition to its famous family of air and hydraulic cylinders, the all new Series K Square Head Air Cylinders. Every effort has been made to carry on the tradition of high quality that industry has learned to expect from Ortman-Miller. Such factors as experience, engineering, design, craftsmanship, and the highest quality components have been skillfully blended to assure the high standards of quality.

The O-M Series K cylinders have been designed for maximum operating efficiency, long life, and quick and easy maintenance.

For complete details write for Bulletin No. 115 in which all cylinders have been dimensioned in accordance with NFPA recommendations for your convenience.

ORTMAN-MILLER MACHINE CO.
1143rd Street, Hammond, Ind.
☐ Have representative call.
☐ Send Bulletin 115
Name_____ Position_____
Company_____
Address_____
City_____ Zone___ State_____

Circle **92** on Reader Service Card

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Precision Rubber appoints sales manager

Clymer

Precision Rubber Products Corp., Dayton, Ohio, has appointed Roy B. Clymer as sales manager in charge of national sales activities. Clymer has broad experience in all types of molded synthetic rubber parts. He was manager of the Dayton district office for Acushnet Process Co., where he worked with automotive and appliance industries and the military services.

Weatherhead moves

The Weatherhead Co., Cleveland, has moved their sales and engineering dept. from Fort Wayne to the administrative headquarters in Cleveland. This change has brought the appointment of S. C. Howell as general sales manager in charge of all domestic sales, except original equipment to automotive manufacturers. Sales to automotive manufacturers will be handled by A. S. Wade as general sales manager. R. T. Marette has been named director of engineering for all six manufacturing plants in the U. S. All manufacturing activities in the U. S. have been placed under J. P. Weatherhead acting as manufacturing manager. P. W. Morse will be industrial sales manager to head all domestic industrial product sales. W. W. Bortner will be sales manager for the product line serving the aviation and missile industry. Robert Veraar will act as sales manager of hydraulic and pneumatic components.

Meletron changes sales policy

Meletron Corp., Los Angeles, manufacturer of pressure switches, took over national sales distribution of all its products. Standard switches are presently being shipped from the factory, but new stocking points are being established in industrial centers. This move was caused by stepped up demands for pressure sensing devices in the space industry.

Continued on page 142

Rucker moves Southern California facilities

The Rucker Co., with headquarters and main factory in Oakland, celebrated its twentieth year by moving its Southern California operations to a new facility in Los Angeles. The new building contains four times the area of the former plant. This is the fourth move to larger quarters by Rucker since 1948. Thomas S. Cozzens will be sales manager in this region. He replaces Donald A. Anderson, now assistant to the vice president.

Circle **30** on Reader Service Card

NEW HEAVY DUTY 7/8" BORE MINIATURE CYLINDERS

Double Acting and Spring Return

Maximum Pressure 250 psi AIR — 2500 psi HYDRAULIC, NON-SHOCK

• Now, a rugged, extra powerful miniature cylinder with all the features desired by designers! Ideal for automation equipment, jigs and fixtures where extra speed and stamina is called for and savings in space, air and cost are necessary. COMPACT: space-saving screw-together construction. INTERNAL CUSHIONS: of resilient Buna-N reduce shock and noise 80%. MOUNTS: Clevis rear, stud front or rear, or foot. ALL PARTS & SEALS: replaceable. PORTS: standard ⅛" NPT on side. TUBES: brass. RODS: high carbon steel, hard chrome plated. SHAFT BUSHINGS: Sintered bronze.
Six STANDARD STROKES available.

Clippard Minimatics

Write for NEW BULLETIN NO. 161

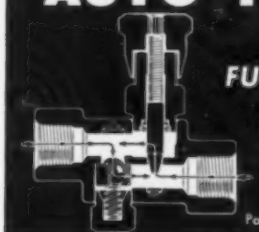
Clippard INSTRUMENT LABORATORY, INC.

7386 Colerain Rd., Cincinnati 39, O. • Phone: JAcksen 1-4261

Manufacturers of Miniature Pneumatic Devices, R.F. Coils, Electronic Equipment

AUTO-PONENT®

HYDRAULIC FULL FLOW VALVES



Flow Control, Needle, Check, for HYDRAULIC Power

Model KF Flow Control Valve with Dial and Knob adjustment for direct reading and duplicating reference. Now available in Aluminum for 3000 psi.

Pat. #2,841, 174

A complete line: ⅛", ¼", ⅜", ½", and ¾" female Dryseal Pipe Sizes in all models and types. Equivalent Aeronautical Tube Sizes on special order.

MINIMUM PRESSURE DROP AND POWER LOSS . . . Oversize ports and passages give maximum flow at minimum pressure drop, insure greater accuracy and response in hydraulic or large volume air cylinder control.

EASY FLOW ADJUSTMENTS under full pressure. Seal located at port to eliminate air or dirt traps. Gland structure equally effective on pressure or vacuum.

SENSITIVE, CHATTERLESS BALL CHECK . . . Patented design insures rapid ball movement to open or close at low differentials.

FORGED BODIES permit higher pressures with wide safety margins. Aluminum—3000 psi; Steel and Stainless Steel—5,000 psi. Pressure ratings based on better than 5 to 1 safety factor. All internal parts are Stainless. Write for illustrated catalog.

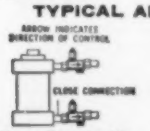
Model F Standard Flow Control Valve or Model H Needle Valve

Model KF Knob and Dial Flow Control Valve or Model KH Needle Valve.

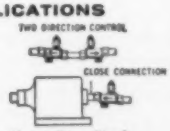
Model PF Knob and Dial Flow Control Valve or Model PH Needle Valve for panel mounting.

Model C Check Valve for In-Line Mounting.

TYPICAL APPLICATIONS



Controlling Double Acting Cylinder



Controlling Single Acting Cylinder

AUTOMATION AUTO PONENTS INC COMPONENTS

2919 GRANT STREET
BELLWOOD (Chicago Suburb) ILLINOIS

Circle **14** on Reader Service Card

Mr. Design Engineer:

we take the "cuss" out of CUStomer problems involving Precision Metal Parts

AERO GASKET . . . experienced at solving tough assignments for design engineers . . . is especially organized for custom designing and manufacturing precision metal parts — including stampings and machined parts. AERO GASKET can produce precision metal parts made of any metal and with any finish presently available.

AERO GASKET welcomes the challenge of difficult jobs involving precision metal parts . . . or molded parts, diaphragms, diaphragm assemblies, seals and gaskets. SEND PRINTS AND DETAILS FOR PROMPT QUOTATIONS.

MAIL COUPON FOR DATA SHEETS

THE AERO GASKET CORPORATION
24 Hanover Street, Meriden, Conn.

☐ Please send me the Data Sheets describing Aero Gasket Precision Metal Parts.

I am also interested in:
☐ Precision Molded Parts ☐ Seals and Gaskets
☐ Diaphragms and Diaphragm Assemblies

name _____
company _____
co. address _____
city _____ zone ____ state _____

THE **AERO Gasket** CORPORATION
Meriden, Connecticut

DIAPHRAGMS • ACTUATORS • ACCUMULATORS
METALLIC & NONMETALLIC GASKETS
CLAMPS OF ALL TYPES AND DESCRIPTIONS
MOLDED RUBBER PARTS • METAL STAMPINGS • METAL-TO-RUBBER BONDING

Circle **4** on Reader Service Card

POST SCRIPTS OF INDUSTRY

New York Air Brake promotes Jarvis, names mgr. mfg.

W. Gordon Jarvis has been promoted to general manager of New York Air Brake Co., Hydreco Div., Kalamazoo, Mich. Jarvis has been with Hydreco for five years. He has served as manager of manufacturing.

Kenneth A. Main has been promoted to manager of manufacturing for Hydreco Div. Main started

Jarvis

Main

with the company's Watertown Div. in 1954. His most recent position has been as manager of time standards and methods.

DEPENDABILITY

THESE HANDS MOLD precision hydraulic cylinder components. Their years of experience skillfully extract quality parts from raw stock — your guarantee of dependability. These adroit hands dare to test their skill with rigid, station-by-station inspection. Every cylinder conforms to the industry's highest standards. CROSS hydraulic cylinders are designed and built for varied, rigorous industrial applications. Write today for specifications. If it's not in stock, CROSS will customize a unit to fit your need.

CROSS MANUFACTURING COMPANY

Lewis, Kansas / Phone EA 4-5525

CROSS Engineers Available to You for Free Consultation!

Circle 34 on Reader Service Card

Biever joins Equipment Sales

Biever Air & Hydraulics has joined Equipment Sales Co., Inc., Atlanta, Ga. As the Fluid Power Div., they will retain most of the former Biever line.

In error . . .

We transposed the captions of two photos in our February 1961 issue. Below are pictured Jules Kovacs, vice president and director of engineering of Purolator Products, Inc., Rahway, N. J.; and William J. Fath, director of manufacturing, H-P-M Div., Koehring Co., Mt. Gilead, Ohio.

Fath

Kovacs

New distributors

Park City Supply Co., Bridgeport, will be a distributor of hydraulic accumulators for Parker-Hannifin Corp., Cleveland. *P. D. Brown Co.*, Dallas, will serve Oklahoma with its new Tulsa office. They will be manufacturer representative for various Parker-Hannifin products including cylinders, air control valves, presses and power units, regulators, filters, and lubricators.

Air Draulics Sales Co., Memphis, handles De Line of hydraulic components made by H-P-M Div., Koehring Co., Mount Gilead, Ohio. Territory is western Tennessee and Arkansas.

Coleman Co., Inc., Greenville, South Carolina, has been appointed by Parker-Hannifin Corp., Cleveland, to distribute the Hydra-Ride accumulator. The Coleman firm will maintain stocks for prompt handling of customer demands.

Air-Oil Products, Inc., Cleveland, has been formed to succeed Holden Engineering Co. Air Oil will handle products of Parker-Hannifin Corp., Webster Electric Co., Spencer Hydraulics, Inc., Pneu-Tool, Inc., Auto-Ponents, Inc. and Circle Seal Products Co.

Continued on page 144

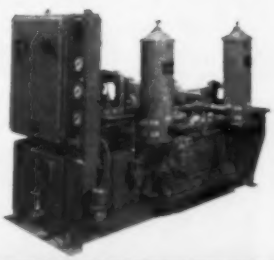
Circle **25** on Reader Service Card

CARDWELL
Trademark
SINCE 1829

CUSTOM ENGINEERING IN INDUSTRIAL HYDRAULICS

Design and fabrication of power units, hydraulic or electrical control panels, and accumulators. Stocking distributors for leading hydraulic components.

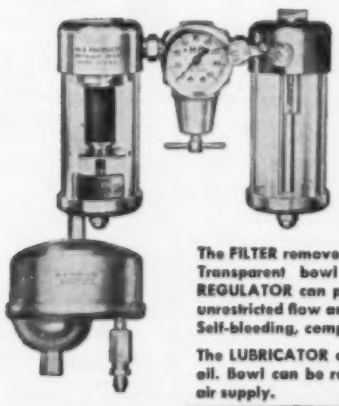
Talk over your special needs with the Cardwell Service Engineer in your area.



The CARDWELL MACHINE COMPANY
Quality — A CARDWELL TRADITION SINCE 1829
Franklin at 19th St., Richmond 11, Virginia • Phone MIlton 4-4593

GREATER PROTECTION to your AIR LINE!
M-B

WHIRL-A-WAY FILTER, REGULATOR AND LUBRICATOR ASSEMBLY AND AUTOMATIC AIR TRAP (MODEL W-4)



SUCCESSFULLY USED FOR PROTECTION OF AIR VALVES CYLINDERS CONTROLS PNEUMATIC TOOLS, ETC.

The FILTER removes solids .00039 and larger. Transparent bowl provides visibility. The REGULATOR can pass large volume with an unrestricted flow and minimum pressure drop. Self-bleeding, compact.

The LUBRICATOR delivers desired volume of oil. Bowl can be refilled without shutting off air supply.

The Air Trap is automatic and eliminates manual draining.

M-B PRODUCTS
46 VICTOR AVE., Div. 12
DETROIT 3, MICHIGAN

Circle **74** on Reader Service Card

H·I·S

PRECISION
TEFLON* "U" Cups
FOR
LOW FRICTION-----
---HIGH TEMPERATURE
in any hydraulic fluid

Style 4505 "U" cups are accurately machined of virgin TEFLON to a special design developed by HALOGEN. 246 standard sizes are available without tooling charges.

Also available:
HALOGEN "V" RINGS
two types available for packed cylinders and other applications.

Write for literature . . . our new 12 page brochure on "U" cups is yours for the asking.

HALOGEN
INSULATOR & SEAL CORP.
9960 Pacific Ave. • Franklin Park, Ill.
"Engineers and manufacturers— TEFLON Products"*

*DuPont T.M.

Circle **49** on Reader Service Card

Circle 2 on Reader Service Card

Fall . . . *the original*

SPRING-LOADED

Wiper **Ring**

This patented closed joint ring provides squeeze - grip action, assuring complete contact on the rod at all times. Maintains uniform, continuous pressure on wiper edge. Rods are always clean in any temperatures.

Fall "CJ" Wiper Rings operate most effectively under extreme conditions of dust, glaze, oil, grit, powder, gases, sand, ice, etc. Available in diameters ½" through 13". For any commercial use. Used by military and aviation industry since 1944.

ACE PRODUCTS CO.

1820 N. 12th St. Toledo 1, Ohio

Est. 1935

POST SCRIPTS OF INDUSTRY

The Kenett Corp., Brookline, Mass., has been appointed to handle the hydraulic valves of Brand Hydraulics, Inc., Omaha, Nebr., and rotary actuators of Roto-Tork Mfg. Co., St. Clair Shores, Mich.

Westinghouse Air Brake Co., Industrial Products Div., Wilmerding, Pa., has announced *H. R. Taylor & Co., Inc.*, Indianapolis, as a representative of Petch cylinders. The territory covered will be Indianapolis and Southern Indiana.

You can win up to $500 by entering the
1961 FLUID POWER PRIZE PAPER CONTEST
For details circle 220 on reader service card

Hydro-Line Mfg. Co., Rockford, Ill., will have *Neff Engineering Co.* handle all fluid power products. Neff will represent Hydro-Line in Indiana and Wisconsin, except for the Louisville and Minneapolis trading areas.

NINE WEST GERMAN authorities in the field of pneumatics visited Ross Operating Valve Co., Detroit, to learn new methods and applications in the field of pneumatics. Russell J. Cameron (second from right) Ross president, explains one of his company's products to the group. Looking on is Robert Dickey (extreme right) Ross sales manager.

Circle 5 on Reader Service Card

new ROTORAM® VALVES

WITH EXCLUSIVE ROTATING STEM

for MILLIONS of TROUBLE-FREE ACTUATIONS

Treadle Valve

Knob Valve

Cam Valve

Finger Valve

Pedal Valve

Hand Ball Valve

- Low silhouette mounting
- 2024 T4 aluminum bar stock
- Rust-resistant
- Full flow air passages
- Piped exhaust ports
- Interchangeable parts
- Anodized finish

Rotoram Valves are available in 3 and 4-way models for ⅛", ¼", ⅜" and ½" pipe sizes. Special Block "V" Packing permits free ram movement, insures long valve life. Port entry from either left or right side. Ask your AIR-MITE Distributor, or write for complete details and illustrated catalog.

AIR-MITE DEVICES, INC.

4401 W. Kinzie St., Chicago 24, Ill.

Circle 119 on Reader Service Card

TRU-SEAL Saves hours in piping installations

TEFLON SEAL

PAT. PENDING

Eliminates leaks in oil, air, water, vacuum, chemical lines

Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—*without the use of pipe dope.* Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.

For further information write

TRU-SEAL DIVISION
FLICK REEDY CORPORATION
7N017 York Rd., Bensenville, Ill.

"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.

1 Thread Tru-Seal on pipe or fitting as far as it will go hand tight.

2 Thread pipe or fitting 3 threads into port. Point in desired direction.

3 Tighten Tru-Seal to complete leakproof assembly (only light torque required).

Circle **62** on Reader Service Card

NEW HEAVY DUTY TYPE KEBBY TANK-TRAPPER

. . . low cost magnetic unit for hydraulic reservoirs

- **"DOUBLE MAGNETIZATION"**
- **CUTS MACHINE DOWN TIME**
- **REDUCES MAINTENANCE**
- **MORE DURABLE**
- **MASSIVE APPEARANCE**

Write, wire or phone WO 3-1466 for informatios and prices.

KEBBY COMPANY
2320 Custer Ave. • Rockford, Illinois
MANUFACTURERS OF MAGNETIC DEVICES

MARKET PLACE

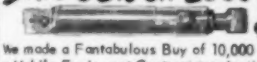
When replying to a box number in the Market Place, address your letter to Hydraulics & Pneumatics, 812 Huron Road, Cleveland 15, Ohio. Attention: Box No.

LINES WANTED

Manufacturers of Hydraulic and Pneumatic Equipment are invited to use the resources of our United Kingdom technical sales and marketing organization. We are Hydraulic Engineers marketing a line of specialty products, and we also design and install complete systems. We require other items to augment our own line to enable us to market a complete range of products and services, and we are prepared to issue stock orders for suitable items. Each item would be exploited individually as well as being marketed with our own line. We shall be pleased to hear from manufacturers who have suitable lines to offer. Write Box 4161, HYDRAULICS & PNEUMATICS.

Classified Advertising Rates: Twenty dollars for the first inch and fifteen dollars for each additional inch or fraction thereof. Rates for Display Ads in this section will be sent on request.

SAVE 82% ON 2000 PSI - HVY. DUTY HYDRAULIC CYLINDERS



We made a Fantabulous Buy of 10,000 Hydraulic Cylinders due to a Mobile Equipment Contract termination. These cylinders were engineered for Earth Moving Equipment, Presses, Tail Gates, Agricultural Equip., Industrial Machines, Lift Assemblies, etc.

Part No	Bore	Stroke	Eye-to-Eye Length	Shaft Dia.	PRICE
H-70A	2½"	8⅜"	18¾"	1½"	9.88
H-70B	2½"	10"	21¼"	1½"	10.88
H-70D	2½"	23¾"	35½"	1½"	18.88
H-70E	2½"	30"	40½"	1½"	24.88
H-70F	2½"	48½"	64⅜"	2"	29.88
H-70G	3½"	8"	19"	2"	17.88
H-70H	3½"	10¼"	21¼"	2"	19.88
H-70J	3½"	22½"	34¼"	2"	29.88
H-70K	3½"	30"	41"	1¾"	34.88
H-70L	3½"	43½"	55⅛"	1¾"	44.88
H-70M	3½"	47"	64½"	2"	49.88
H-70N	4"	22¼"	34⅜"	2"	36.88

SPECIAL! palley's

PISTON TYPE HYDRAULIC MOTORS
2000 PSI intermittent
3000 PSI continuous

SAVE - On these famous make hydraulic motors. Just purchased from Gov't Surplus. All are unused and in good condition.

No. V-241 - Hydraulic PUMP – Displaces 2.41 cubic inches per rev. Has a manual by-pass valve. Develops 393.5 lb. in. torque at 1000 PSI. Maximum operating speed is 2200 RPM. Has 1" dia., 6-spline shaft.
NOW ONLY . . . $175

No. V-598 - Hydraulic PUMP – Displaces 5.98 cu. in. per revolution. Develops 953 lb. in. torque at 1000 PSI. Max. operating speed 1600 RPM. Has a manual by-pass valve, 1-1/4" dia., 6-spline shaft . . . .
SAVE AT 295.00

NEW SAVE ON NEW HYDRAULIC "HI-LO" PRESSURE PUMPING UNIT

No. DPR-21-3000

Ideal for use in applications where a fast approach to the work load is desired. Will deliver a total combined volume of both the pumps of 21 GPM . . . at pressures up to 500 PSI, then delivers output of the high pressure pump (4 GPM) at up to 3000 PSI. Both pumps are face mounted on a 7-1/2 HP, double-end, 220/440, 3-phase, 60 cycle AC motor. Entire pumping unit mounted on a 33 gallon reservoir (available without the reservoir). Overall size is 35" long x 18-1/2" wide x 18-1/2" high. Other Hi-Lo units available from 1500 PSI to 3000 PSI – WRITE for DETAILS!

palley's NOW 785.00

2263 E. VERNON AVE., Dept. AH-51
LOS ANGELES 58, CALIFORNIA

TO ORDER: Send check or M.O. ½ dep. with C.O.D.'s. All items sent freight or postage collect.

SPECIAL VALUE G.I AIR TANKS
Stainless steel. Tested to 400 PSI. Ideal for storage of air, chemicals, acids, etc. Has ¼" pipe ports. Size: 12-1/2" dia. x 24" long. NOW 11.95

Circle **94** on Reader Service Card

WATERMAN

Series 1617

D.C. 4-WAY SOLENOID VALVES

High pressure
Low leakage
No dynamic seals

Complete range of types—closed-center, tandem, two-position configurations, etc.

3000 p.s.i. pressure—rated pressure may be applied to all ports.

Operate solenoids without flow or pressure.

Light and compact—weighs only 5 pounds complete.

All moving parts operating in oil.

Simple stacking or banking of any number of valves with standard kits. Allows you to add on later.

Send today for new Catalog 2002

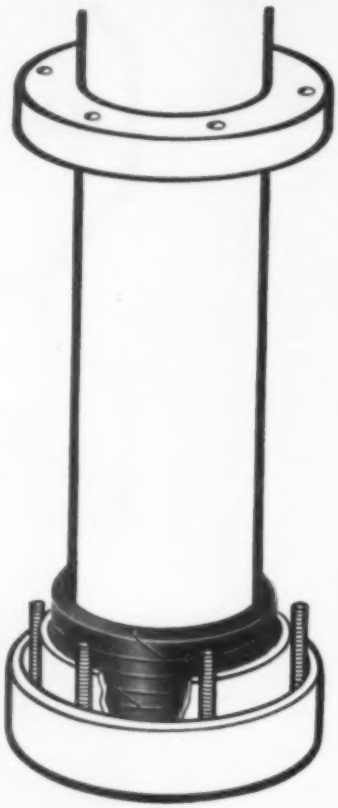
NFPA

W-6110

WATERMAN HYDRAULICS CORPORATION

725 Custer Ave., Evanston, Ill.

Circle **123** on Reader Service Card



R/M CAPABILITY PRODUCES VEE-FLEX® PACKINGS

for positive sealing against all hydraulic and pneumatic pressures

Whether you are designing pumps, valves, hydraulic cylinders, rams, presses, shock absorbers or similar equipment—R/M Vee-Flex Packings will more than meet your requirements. They provide a positive seal against all hydraulic and pneumatic pressures used in industrial equipment. They give outstanding service against air, water, steam, petroleum products, other commercial fluids, and food products. Designers are especially interested in these characteristics:

- Self-adjusting
- Require only finger-tight gland adjustment
- Longer life with fewer adjustments
- Available in combinations of materials, including various elastomers, duck and asbestos, solid Teflon,* Teflon-impregnated

Write for your copy of new Catalog P-100 which contains complete details.

**Registered trademark for Du Pont fluorocarbon resins*

RAYBESTOS-MANHATTAN, INC.

RM PACKINGS

PACKING DIVISION, PASSAIC, N.J.

MECHANICAL PACKINGS AND GASKET MATERIALS

Circle **103** on Reader Service Card

ADVERTISERS' INDEX
April 1961

A & A Mfg. Co., Inc. 129
Ace Products Co. 144
Adel Precision Products Div., General Metals Corp. 96
Aero Gasket Corp. 141
Air-Mite Devices, Inc. 144
American Measurement & Control, Inc. 20
American-Standard, Controls Div., Rochester Instrument Plant 121
Anchor Coupling Co., Inc. 5
Anker-Holth Mfg. Co., Div. Wellman Engineering Co. 65
Raymond Atchley Div., American Brake Shoe Co. 125
Automatic Switch Co. ..... Cover 3
Auto-Ponents, Inc. 133, 141

Babcock & Wilcox Co., Tubular Products Div. 56
Barksdale Valves 38
Bellows-Valvair, Div. IBEC 101
Bendix-Westinghouse Automotive Air Brake Co. 35
Benton Harbor Engineering Works, Inc. 116
Boonshaft & Fuchs 112
Bruning Co. 134

Capital Engineering & Mfg. Corp. 136
Cardair, Div. Marmon-Herrington Co. 88
Cardwell Machine Co. 143
Chamberlain Industries Ltd. 129
Char-Lynn Co. 4
Chicago Rawhide Mfg. Co. 119
Chiksan Co. 12, 13
Clippard Instrument Laboratory, Inc. 141
Commercial Filters Corp. 66
Commercial Shearing & Stamping Co. 81
Crane Packing Co. 53
Cross Manufacturing Co. 142

Darling Valve & Mfg. Co. 22
Denison Engineering Div., American Brake Shoe Co. 109
Dynex, Inc. 47

Eastern Industries, Inc. 113
Electro-Hydraulics Ltd. 110
Ex-Cell-O Corp., Rotac Div. 54

Fluid Controls, Inc. 123
Fluid Power Accessories 125
Fulflo Specialties Co., Inc. 130

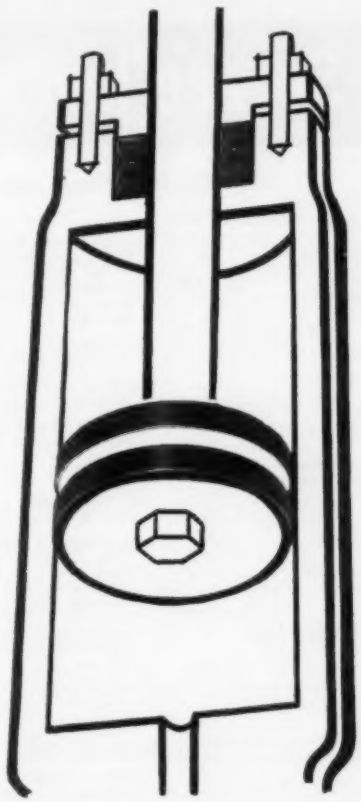
Garlock, Inc. 15
Gast Mfg. Co. 8
Gates Rubber Co. 83
Greer Hydraulics, Inc. 126
Gresen Mfg. Co. 136

H-P-M Div., Koehring Co. 36
Halogen Insulator & Seal Corp. 143
Hanna Engineering Works 1
Hansen Mfg. Co. ..... Cover 2
Haskel Engineering & Supply Co. 114
Helicoid Gage Div., American Chain & Cable Co. 118
Hoke, Inc. 115
Hunt Valve Co., Div. IBEC 31
Hydraulic Accessories Co. 139
Hydraulic Research & Mfg. Co., Div. Bell Aerospace Corp., Standard Valve Div. 102
Hydraulic Unit Specialties Co. 125
Hydro-Line Mfg. Co. 51

Imperial-Eastman Corp. 122, 123
International Packings Corp. 46

Kebby Co. 145
Keelavite Hydraulics Ltd. 17
Kepner Products Co. 125
Koontz Wagner Electric Co., Inc. 117

Koppers Co., Inc., Metal Products Div. 107
Lassman & Son, Benjamin 50
Lee Co. 37
Le Roi Div., Westinghouse Air Brake Co. 131
Linear, Inc. 64
Lisle Corp. 100
Lockheed Precision Products Ltd., Industrial Hydraulics Div. 39
Lucas-Rotax Ltd. 127
M-B Products, Inc. 143
M. C. Mfg. Co. 117
Manatrol Corp. 139
Marsh Instrument Co., Div. Colorado Oil & Gas Corp. 117
Marvel Engineering Co. 6, 7
Master Pneumatic, Inc. 132
Mead Fluid Dynamics, Div. Mead Specialties Co. 28
Meletron Corp. 59
Miller Fluid Power Div., Flick-Reedy Corp. 57
Milwaukee Cylinder Co., Div. L & M Machine Co. 135
Minnesota Rubber Co. 2
Mo-Bar Hydraulics Co. 133
Modernair Corp. 21
Monsanto Chemical Co., Organic Chemicals Div. 26, 27
National Seal Div., Federal-Mogul-Bower Bearings, Inc. 18
Niagara Blower Co. 137
C. A. Norgren Co. 48, 49
Ohio Seamless Tube Div., Copperweld Steel Co. 23
Oilgear Co. 9
Ortman-Miller Machine Co. 140
Owatonna Tool Co. 14
Palley Supply Co. 145
Parker Fittings & Hose Div., Parker-Hannifin Corp. 60, 61
Pokorny Pow-R-Trol Products, Inc. 120
Polymer Corp. of Penna. 124
Precision Rubber Products Corp. 44
Racine Hydraulics & Machinery, Inc. 40, 41, 42, 43
Raybestos-Manhattan, Inc. 146, 147
Republic Mfg. Co. 135
Rivett Lathe & Grinder, Inc. 19
Roper Hydraulics, Inc. 138
Ross Operating Valve Co. 11, 135
Russell, Burdsall & Ward Bolt & Nut Co. 24
Sheffer Corp. 139
Shell Oil Co. 45
Skinner Electric Valve Div., Skinner Precision Industries, Inc. 33, 34
Stratoflex, Inc. 16
Sundstrand Hydraulics, Div. Sundstrand Corp. 85
Superior Tube Co. 133
Super Oil Seals & Gaskets Ltd. 29
Tomkins-Johnson Co. 93
Tru-Seal Div., Flick-Reedy Corp. 144
Universal Hydraulics, Div. Holan Corp. 137
Vickers, Inc., Div. Sperry Rand Corp. Mobile Hydraulics Div. 67, 68
Henry Vogt Machine Co. 89
Waterman Hydraulics Corp. 145
Watertown Div., New York Air Brake Co. 111
Webster Electric Co., Oil Hydraulics Div. 55
Westinghouse Air Brake Co., Industrial Products Div. 25
Wilkerson Corp. 128
Wooster Div., Borg-Warner Corp. 63
Young Radiator Co. 52



R/M CAPABILITY PRODUCES PRECISION PISTON CUPS

for sure sealing and high resistance to extrusion

Consider these important advantages of R/M piston cups. They are designed and precision molded to assure dimensional uniformity and maximum sealing efficiency. R/M uses a processing technique that gives deep fabric impregnation. They offer minimum friction and maximum resistance to extrusion. Of particular interest to designers are the following advantages:

- R/M piston cups are made in standard sizes to fit cylinders ranging in diameter from ½ to 12 in.
- R/M piston cups are molded in varying degrees of hardness and in combinations of materials including various elastomers, duck and asbestos, solid Teflon* and Teflon-impregnated

For complete data, including service recommendations, write for our new Mechanical Packings and Gasket Materials Catalog P-100. It covers R/M piston cups to suit all your most exacting needs.

Registered trademark for Du Pont fluorocarbon resins

RAYBESTOS-MANHATTAN, INC.

R/M **PACKINGS**

PACKING DIVISION, PASSAIC, N.J.

MECHANICAL PACKINGS AND GASKET MATERIALS

Circle **104** on Reader Service Card

Reader Service Index

Circle numbers on these post cards for more information.

See advertisers' index on pages 146-147 for location of ads

Circle No.

ACCUMULATORS
Cardwell Machine Co. 25
Greer Hydraulics, Inc. 130

ACTUATORS, ROTARY
Ex-Cell-O Corp. 40

AFTERCOOLERS
Niagara Blower Co. 89

AIR COMPRESSORS
Gast Mfg. Corp. 45
Le Roi Div. 70

AIR COMPRESSORS, AIRCRAFT
M. C. Mfg. Co. 75

AIR FILTERS, REGULATORS, LUBRICATORS & ACCESSORIES
Commercial Filters Corp. 31
Hoke, Inc. 54
M-B Products, Inc. 74
Master Pneumatic, Inc. 78
C. A. Norgen Co. 90
Westinghouse Air Brake Co. 126
Wilkerson Corp. 127

AIR MOTORS
Gast Mfg. Corp. 45

AIR TANKS
Palley Supply Co. 94

BELLOWS
A&A Mfg. Co., Inc. 1

BOOSTERS
Miller Fluid Power Div. 82

BOOTS
A&A Mfg. Co., Inc. 1

CONTROL PANELS
Cardwell Machine Co. 25

CYLINDERS
Anker-Holth Div. 10
Bendix-Westinghouse Automotive Air Brake Co. 19
Benton Harbor Engineering Works, Inc. 20
Clippard Instrument Laboratory, Inc. 30
Cross Manufacturing Co. 34
Hanna Engineering Works 50
Hydro-Line Mfg. Co. 59
Lockheed Precision Products Ltd. 15
Milwaukee Cylinder Co. 83
Mo-Bar Hydraulics Co. 85
Modernair Corp. 86
Ortman-Miller Machine Co. 92
Owatonna Tool Co. 93
Palley Supply Co. 94
Sheffer Corp. 111
Tomkins-Johnson Co. 118
Universal Hydraulics 120
Westinghouse Air Brake Co. 126

DEHYDRATION EQUIPMENT
Wilkerson Corp. 127

FILTERS, HYDRAULIC
Capital Engineering & Mfg. Corp. .. 23
Commercial Filters Corp. 31
Marvel Engineering Co. ..... —

FLUID MOTORS
Chamberlain Industries Ltd. 26
Keelavite Hydraulics Ltd. 63
Palley Supply Co. 94
Webster Electric Co. 125

FLUID STEERING SERVOCONTROL
Char-Lynn Co. 27

GAS COMPRESSORS
Cardair 24
Haskel Engineering & Supply Co. 52

HEAT EXCHANGERS
Young Radiator Co. 129

HOSE, FITTINGS & ASSEMBLIES
Anchor Coupling Co., Inc. 9
Gates Rubber Co. 46
Imperial-Eastman Corp. 60
Parker Fittings & Hose Div. 95
Polymer Corp. of Penna. 97
Stratoflex, Inc. 114

Circle No.

HYDRAULIC CHECKING UNIT
Pokorny Pow-R-Trol Products, Inc. 96

HYDRAULIC FLUIDS
Monsanto Chemical Co. 87
Shell Oil Co. 112

HYDROSTATIC TRANSMISSIONS
Watertown Div. 124

JOINTS, ROTARY, SWIVEL
Chiksan Co. 29

MAGNETIC PLUGS, SEPARATORS & STRAINERS
Kebby Co. 62
Lisle Corp. 72

OIL COOLERS
Young Radiator Co. 129

PACKINGS & SEALS
Aero Gasket Corp. 4
Crane Packing Co. 33
Darling Valve & Mfg. Co. 35
Garlock, Inc. 44
Halogen Insulator & Seal Corp. 49
Hydraulic Accessories Co. 56
International Packings Corp. 61
Linear, Inc. 71
Minnesota Rubber Co. 84
National Seal Div. 88
Precision Rubber Products Corp. 98
Raybestos-Manhattan, Inc. 103, 104
Super Oil Seals & Gaskets, Ltd. 117
Tru-Seal Div. 119

PIPE & TUBE BENDERS
Chamberlain Industries Ltd. 26

PISTON RINGS
Koppers Co., Inc. 66

PLUGS
Lee Co. 69
Russell, Burdsall & Ward Bolt and Nut Co. 110

PLUMBING TOOLS
Imperial-Eastman Corp. 60

POWER UNITS
Cardwell Machine Co. 25
Palley Supply Co. 94
Racine Hydraulics & Machinery, Inc. 100

PRESSURE GAGES
American-Standard, Controls Div. 7
Helicoid Gage Division 53
Marsh Instrument Co. 77

PRESSURE SWITCHES
Hoke, Inc. 54
Meletron Corp. 81

PUMPS
Adel Precision Products 3
Denison Engineering Div. 36
Eastern Industries, Inc. 38
Keelavite Hydraulics Ltd. 63
Lucas-Rotax Ltd. 73
Oilgear Company ..... —
Palley Supply Co. 94
Racine Hydraulics & Machinery, Inc. 100, 102
Roper Hydraulics, Inc. 107
Sundstrand Hydraulics 115
Webster Electric Co. 125
Wooster Div. 128

PUMPS, VACUUM
Gast Mfg. Corp. 45

QUICK-CONNECT COUPLINGS
Bruning Co. 22
Hansen Mfg. Co. 51
Imperial-Eastman Corp. 60

ROD WIPERS, SCRAPERS & ASSEMBLIES
Ace Products Co. 2
Chicago Rawhide Mfg. Co. 16
Hydraulic Accessories Co. 56

Circle No.

SERVO COMPONENTS
American Measurement & Control, Inc. 6
Raymond Atchley Div. 11
Boonshaft & Fuchs, Inc. 21
Hydraulic Research & Mfg. Co. 57

SERVOVALVES
American Measurement & Control, Inc. 6
Raymond Atchley Div. 11

SLEEVES
A&A Mfg. Co., Inc. 1

SOLENOIDS
Koontz-Wagner Co. 65

THERMOMETERS
American-Standard, Controls Div. 7

TUBE FITTINGS
Anchor Coupling Co., Inc. 8
Imperial-Eastman Corp. 60

TUBING
Babcock & Wilcox Co. 28
Imperial-Eastman Corp. 60
Ohio Seamless Tube Co. 91
Polymer Corp. of Penna. 97
Superior Tube Co. 116

VALVES, AIR
Air-Mite Devices, Inc. 5
Automatic Switch Co. 12
Auto-Ponents, Inc. 13
Barksdale Valves 17
Bellows-Valvair 18
Electro-Hydraulics Ltd. 39
Hunt Valve Co. 55
Imperial-Eastman Corp. 60
Manatrol Corp. 76
Mead Specialties Co. 79
Republic Manufacturing Co. 105
Ross Operating Valve Co. 108, 109
Skinner Electric Valve Div. 113
Westinghouse Air Brake Co. 126

VALVES, AIRCRAFT
Hydraulic Research & Mfg. Co. 57
Kepner Products Co. 64
M. C. Mfg. Co. 75

VALVES, HYDRAULIC
Automatic Switch Co. 12
Auto-Ponents, Inc. 13, 14
Commercial Shearing & Stamping Co. 32
Dynex, Inc. 37
Electro-Hydraulics Ltd. 39
Fluid Controls, Inc. 41
Fluid Power Accessories, Inc. 42
Fulflo Specialities Co., Inc. 43
Gresen Mfg. Co. 47
H-P-M Div., Koehring Co. 48
Hunt Valve Co. 55
Hydraulic Unit Specialties Co. 58
Imperial-Eastman Corp. 60
Kepner Products Co. 64
Benjamin Lassman & Son 68
Manatrol Corp. 76
Mead Specialties Co. 79
Pokorny Pow-R-Trol Products, Inc. .. 96
Racine Hydraulics & Machinery, Inc. 100, 101, 102
Republic Manufacturing Co. 105
Rivett Lathe & Grinder, Inc. 106
Skinner Electric Valve Div. 113
Vickers, Inc. 121
Henry Vogt Machine Co. 122
Waterman Hydraulics Corp. 123

VALVES, WATER
Automatic Switch Co. 12
Hunt Valve Co. 55
Manatrol Corp. 76
Mead Specialties Co. 79
Republic Manufacturing Co. 105
Skinner Electric Valve Div. 113

WAY PROTECTORS
A&A Mfg. Co., Inc. 1

READER SERVICE CARD

Hydraulics & Pneumatics

FOR YOUR CONVENIENCE . . .

to receive further information about products described in this issue, circle the indicated number on the card.

FIRST CLASS
PERMIT NO. 8066
CLEVELAND, OHIO

NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

BUSINESS REPLY MAIL

POSTAGE WILL BE PAID BY:

HYDRAULICS & PNEUMATICS
812 Huron Road
Cleveland 15, Ohio

Card Invalid Without Company Name

April 1961. Do not use after July 15, 1961

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____ KIND OF BUSINESS (or product manufactured) _____

CITY _____ STATE _____ ZONE _____

ADVERTISERS

1	16	31	46	61	76	91	106	121	136	151	166	181	196	211
2	17	32	47	62	77	92	107	122	137	152	167	182	197	212
3	18	33	48	63	78	93	108	123	138	153	168	183	198	213
4	19	34	49	64	79	94	109	124	139	154	169	184	199	214
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216
7	22	37	52	67	82	97	112	127	142	157	172	187	202	217
8	23	38	53	68	83	98	113	128	143	158	173	188	203	218
9	24	39	54	69	84	99	114	129	144	159	174	189	204	219
10	25	40	55	70	85	100	115	130	145	160	175	190	205	220
11	26	41	56	71	86	101	116	131	146	161	176	191	206	221
12	27	42	57	72	87	102	117	132	147	162	177	192	207	222
13	28	43	58	73	88	103	118	133	148	163	178	193	208	223
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225

NEW PRODUCTS

300	311	322	333
301	312	323	334
302	313	324	335
303	314	325	336
304	315	326	337
305	316	327	338
306	317	328	339
307	318	329	340
308	319	330	341
309	320	331	342
310	321	332	343

FREE LITERATURE

400	411	422	433
401	412	423	434
402	413	424	435
403	414	425	436
404	415	426	437
405	416	427	438
406	417	428	439
407	418	429	440
408	419	430	441
409	420	431	442
410	421	432	443

AEROSPACE DATA

500	511	522	533
501	512	523	534
502	513	524	535
503	514	525	536
504	515	526	537
505	516	527	538
506	517	528	539
507	518	529	540
508	519	530	541
509	520	531	542
510	521	532	543

For entry card and rules booklet for the 1961 Fluid Power Prize Paper Contest check here ☐

FIRST CLASS
PERMIT NO. 8066
CLEVELAND, OHIO

NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

BUSINESS REPLY MAIL

POSTAGE WILL BE PAID BY:

HYDRAULICS & PNEUMATICS
812 Huron Road
Cleveland 15, Ohio

Was this copy of HYDRAULICS & PNEUMATICS correctly addressed? If not, use this card to give us your complete mailing address plus the old (incorrect) one.

H&P IS NOW ADDRESSED LIKE THIS:	IT SHOULD BE CHANGED TO THIS:

MAJOR PRODUCTS MANUFACTURED OR TYPE OF BUSINESS AT THIS ADDRESS

MY JOB TITLE

SIGNATURE

FIRST CLASS
PERMIT NO. 8066
CLEVELAND, OHIO

NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

BUSINESS REPLY MAIL

POSTAGE WILL BE PAID BY:

HYDRAULICS & PNEUMATICS
812 Huron Road
Cleveland 15, Ohio

Card Invalid Without Company Name

April 1961. Do not use after July 15, 1961

NAME TITLE

COMPANY

ADDRESS KIND OF BUSINESS (or product manufactured)

CITY STATE ZONE

ADVERTISERS

1	16	31	46	61	76	91	106	121	136	151	166	181	196	211
2	17	32	47	62	77	92	107	122	137	152	167	182	197	212
3	18	33	48	63	78	93	108	123	138	153	168	183	198	213
4	19	34	49	64	79	94	109	124	139	154	169	184	199	214
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216
7	22	37	52	67	82	97	112	127	142	157	172	187	202	217
8	23	38	53	68	83	98	113	128	143	158	173	188	203	218
9	24	39	54	69	84	99	114	129	144	159	174	189	204	219
10	25	40	55	70	85	100	115	130	145	160	175	190	205	220
11	26	41	56	71	86	101	116	131	146	161	176	191	206	221
12	27	42	57	72	87	102	117	132	147	162	177	192	207	222
13	28	43	58	73	88	103	118	133	148	163	178	193	208	223
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225

NEW PRODUCTS

300	311	322	333
301	312	323	334
302	313	324	335
303	314	325	336
304	315	326	337
305	316	327	338
306	317	328	339
307	318	329	340
308	319	330	341
309	320	331	342
310	321	332	343

FREE LITERATURE

400	411	422	433
401	412	423	434
402	413	424	435
403	414	425	436
404	415	426	437
405	416	427	438
406	417	428	439
407	418	429	440
408	419	430	441
409	420	431	442
410	421	432	443

AEROSPACE DATA

500	511	522	533
501	512	523	534
502	513	524	535
503	514	525	536
504	515	526	537
505	516	527	538
506	517	528	539
507	518	529	540
508	519	530	541
509	520	531	542
510	521	532	543

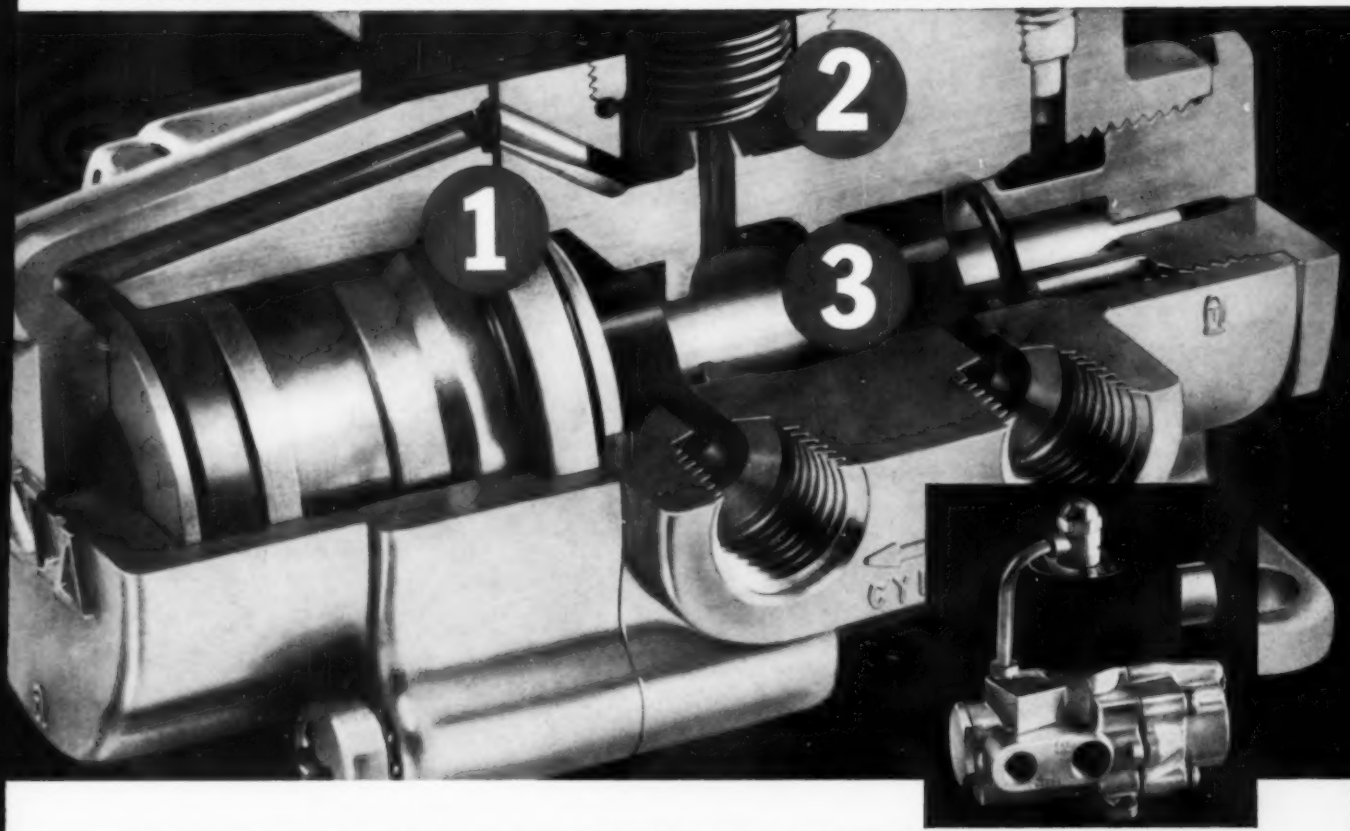
For entry card and rules booklet for the 1961 Fluid Power Prize Paper Contest check here ☐

READER SERVICE CARD

Hydraulics & Pneumatics

this is the way a valve is built to last

MILLIONS OF OPERATIONS:



NEW LOW-COST ASCO 4-WAY SOLENOID VALVES HAVE BEEN CYCLED MILLIONS OF OPERATIONS WITHOUT FAILURE

1. **TIGHT SEATING** with unique patented poppet-type seats—Patent Nos. 2,624,585—2,775,982
2. **RELIABLE OPERATION ASSURED**—failure to return due to residual magnetism is eliminated
3. **POWER OPERATION IN BOTH DIRECTIONS**—main valve not dependent upon return springs

Installation is simplified; the 8344 may be mounted in any position!

Poppet seals and a unique combination of metal-to-metal with resilient seating enable these and other ASCO 4-way solenoid valves to provide dead-tight shut-off, even on air, without lapping, grinding or close adjustments. The utter simplicity of design, eliminating return springs and power-operating the main valve in both directions, assures unprecedentedly reliable performance without maintenance for indefinite periods.

The new ASCO Bulletin 8344 valve is the latest embodiment of over half a century's design and development experience. Its low cost makes it economical even as a 3-way valve, with one pipe connection plugged.

Here are the pertinent statistics:

Pipe Size	Catalog No.	Solenoid Enclosures	List Prices†	Operating Information
¼"	83440	Std.	$48.00	Pressures: to 250 psi.
¼"	83444	Expl. proof	56.00	Temp: to 212° F.
⅜"	83441	Std.	48.00	Fluids: air, water, hydraulic oil
⅜"	83445	Expl. proof	56.00	

† Subject to trade and quantity discounts.

Other ASCO 4-way valves come in pipe sizes from ¼" to 1½" for pressures to 500 p.s.i. For complete information write for Catalog 202, and see the hundreds of types of 2, 3, and 4-way solenoid valves available for immediate delivery from the world's largest stock.

ASCO Valves

ASCO

DEPENDABLE CONTROL BY Automatic Switch Co. 50-H HANOVER RD., FLORHAM PARK, N. J. • FRONTIER 7-4600 • AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

Circle **12** on Reader Service Card

Problems are meant to be solved . . . and chances are good someone else is tackling a problem like yours this very minute. It's also a good bet that something seen or read in HYDRAULICS & PNEUMATICS has helped provide the best solution.

HYDRAULICS & PNEUMATICS is written by specialists for men like you. It is edited to solve problems in fluid power design. You are sure to find solutions to many of your problems between the covers of every issue. Take advantage of the HYDRAULICS & PNEUMATICS problem-solving editorial content. And, for full details on any item described or advertised in this issue, just use the handy Time Saver Card.

Franchise Circulation gets magazines to the men who buy

Distilled Writing gets magazines read

Hydraulics & Pneumatics

AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

812 HURON ROAD • CLEVELAND 15, OHIO • SUperior 1-9620 • OFFICES: NEW YORK • CHICAGO • LOS ANGELES • LONDON